Name of Department:- Computer Science and Engineering

1. Subject Code: **TCS 101** Course Title: FUNDAMENTALS OF COMPUTER AND INTRODUCTION TO PROGRAMMING
2. Contact Hours: L: 3 T: - P: -
3. Semester: I

4. Pre-requisite: Basic Knowledge of Mathematics

5. Course Outcomes: After completion of the course students will be able to

1. Learn the concepts of IT and understand the fundamentals of basic building blocks of computer science.
2. Understand basic data types and syntax of C programming. .
3. Propose solution to problem by using tools like algorithm and flowcharts.
4. Analyze and select best possible solution for decision-based problems using decision making skills.
5. Develop the aptitude to solve iterative problems using different types of looping statements.
6. Implement complex problem as a collection of sub problems by applying modularization in applications using functions.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	Generation of computers, Computer system memory hierarchy, Input/Output, RAM/ROM, Software & Hardware, Understand bit, byte, KB, MB, GB and their relations to each other, Operating System overview, Computer Networks Overview Algorithms and Flow Charts – Examples of Flow charts for loops and conditional statements	**8**
Unit - II	First C program - Hello world, How to open a command prompt on Windows or Linux How to read and print on screen - printf(),scanf(),getchar(), putchar() Variables and Data types - Variables, Identifiers, data types and sizes, type conversions, difference between declaration and definition of a variable, Constants Life of a C program (Preprocessing, Compilation, Assembly, Linking, Loading, Execution), Compiling from the command line, Macros, Operators – equality and assignment, Compound assignment operators, Increment and decrement operators, Performance comparison between pre and post increment/decrement operators, bitwise operators (AND, OR, NOT and XOR), Logical Operators, comma operator, precedence and associativity, Logical operators (AND, OR),	**10**
Unit – III	Conditional statements (if statement, if-else statement, ternary statement or ternary operator, nested if-else statement, switch statement), Difference between performance of if else and switch, Advantages of if else and switch over each other	**8**

	Loops – 'for' loops, 'while' loops, 'do while' loops, entry control and exit control, break and continue, nested loops	
Unit – IV	Arrays –Single and Multi-dimensional arrays, Initializing arrays, computing address of an element in array, row major and column major form of an array, character strings and arrays, segmentation fault, bound checking, Sorting Algorithms – Bubble sort, insertion sort, selection sort	**10**
Unit – V	**Functions** – Function prototype, function return type, signature of a function, function arguments, call by value, Function call stack and Activation Records, Recursion v/s Iteration, passing arrays (single and multi-dimensional) to functions, **Storage classes-** Automatic, Static, Register, External, Static and Dynamic linking implementation, C program memory (show different areas of C program memory and where different type of variables are stored), scope rules	**7**
	Total	**43**

Text Books:

- Peter Prinz, Tony Crawford,"C in a Nutshell", 1stEdition, Oreilly Publishers, 2011.
- Peter Norton, "Introduction to computers", 6thEdition, TMH, 2009.

Reference Books:

- Steve Oualline, "Practical C programming", 3rdEdition, Orielly Publishers, 2011.
- Brian W Kernighan, Dennis M Ritcie,"The C Programming Language", 2ndEdition, Prentice Hall, 1988.
R3. Herbert Schildt," C: The Complete Reference", 4thEdition.TMH, 2000.
- E.Balagurusamy,"Programming in ANSI C",6th Edition, McGraw Hill 2015
- YashwantKanetkar,"Let Us C",8th Edition,BPB Publication 2007

Name of Department:- Computer Science and Engineering

1. Subject Code: **TCS 201** Course Title: **Programming for Problem solving**
2. Contact Hours: L: 3 T: - P: -
3. Semester: II

4. Pre-requisite: Basic Knowledge of Mathematics and Computer Fundamentals

5. Course Outcomes: After completion of the course students will be able to

1. Learn and apply concepts of strings for providing solutions to homogenous collection of data types
2. Propose solution to problem by using tools like algorithm and flowcharts.
3. Apply the concept of pointers to optimize memory management by overcoming the limitations of arrays.
4. Process and analyze problems based on heterogeneous collection of data using structures.
5. Apply concepts of file handling to implement data storage and retrieval tasks.
6. Implement the basic real life problems using python

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	Strings – Declaration of strings, Initialization of strings using arrays and pointers, Standard library functions of <string.h>header file, Null-terminated strings, Char arrays and pointers, Pointers and Strings, comparing two strings, find substring in a string, tokenizing a string with strtok() function, pointer-based string-conversion function – atoi()	**6**
Unit - II	**Pointers** –Basic of pointers and addresses, Pointers and arrays, Pointer arithmetic, passing pointers to functions, call by reference, Dynamic memory management in C - malloc(), calloc(), realloc(), free(), memory leak, Dangling, Void, Null and Wild pointers **Structures** - Structures, array of structures, structure within structure, union, typedef, self-referential structure, pointer to structure	**10**
Unit – III	**File Handling** - Opening or creating a file, closing a file, File modes, Reading and writing a text file using getc(), putc(), fprintf() ,fscanf(),fgets(), fputs(),Difference between append and write mode, Reading and writing in a binary file, counting lines in a text file, Search in a text file, Random file accessing methods- feof(), fseek(), ftell() and rewind() functions,	**8**
Unit – IV	**Introduction to Python-** History of Python, Need of Python Programming, Python features, Installation of Python in Windows and Linux, First Python Program, Running python Scripts, Variables, Reserved words, Lines and indentation, Quotations, Comments, Input output. Data Types, Operators and Expressions: Standard Data Types – Numbers, strings, Boolean, Operators – Arithmetic Operators, comparison Operators, assignment Operators, logical Operators, Bitwise Operators.	**10**

Unit-V	Control flow – if, if-elif-else, for, while, break, continue, pass, range(), nested loops, Data structures – List, Tuple, Dictionary File Handling – Reading text file, writing text file, copying one file to another	**10**
	Total	**44**

Text Books:

- Peter Prinz, Tony Crawford,"C in a Nutshell", 1stEdition, Oreilly Publishers, 2011.
- YashwantKanetkar,"Let Us C",8th Edition,BPB Publication 2007

Reference Books:

- Steve Oualline, "Practical C programming", 3rdEdition, Orielly Publishers, 2011.
- Brian W Kernighan, Dennis M Ritcie,"The C Programming Language", 2ndEdition, Prentice Hall, 1988. R3. Herbert Schildt," C: The Complete Reference", 4thEdition.TMH, 2000.
- E.Balagurusamy,"Programming in ANSI C",6th Edition, McGraw Hill 2015

Name of Department:- Computer Science and Engineering

1. Subject Code: **TCS 301** Course Title: **Logic Design**

2. Contact Hours: L: 3 T: - P: -

3. Semester: III

4. Pre-requisite: Basics of Mathematics, Basic knowledge of computer programming and components of computer system

5. Course Outcomes: After completion of the course students will be able to

Illustrate the Binary, Octal, Hexadecimal number system and Gate level minimization using K-Map and Quine-McClusky Method.

Analyze and Design Binary/decimal adder, Binary substractor, Binary multiplier and Multiplexer/Demultiplexer, comaprator, encoder, decoder.

Categorize Flip Flops (RS, JK, D and T).

Classify SISO, SIPO,PISO,PIPO and Design Asynchronous and Synchronous Counters.

Design and Evaluate Synchronous and Asynchronous Sequential circuits.

Investigate digital design problems of the society.

6. Details of Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	**Review of Number System:** Digital Signals and Waveforms, Binary, Octal, Hexadecimal; Complements, Signed Binary Numbers, Arithmetic Operation, Binary Codes, Error Detection and Correction. **Boolean Algebra and Gate Level Minimization:** Basic Definition, Boolean Logic, postulates, Theorems and Properties. Digital Logic Gates, K-Map Method for Minimization upto 6-Variables, Quine-Mc Clusky Method for Minimization, NAND and NOR Gate Implementation.	**10**
Unit - II	**Combinational Logic Circuit:** Combinational circuits, Analysis Procedure, Design Procedure, Binary Adder & Subtractor, Decimal Adder, Binary Multiplier, Magnitude Comparator, Multiplexer, Demultiplexer, Decoder, Encoder, Parity Generator & Checker, Programmable Array Logic, Programmable Logic Array, Code Convertors (BCD, Gray and Seven Segment Code etc.).	**9**
Unit – III	**Sequential Logic Circuits:** Triggering, Latches, Flip Flops: RS, JK, D and T (Characteristics Table, Equation and Excitation Table), Flip Flop Conversion, Race Around Condition, JK Master Slave Flip Flop.	**9**
Unit – IV	**Register:** Types of Register, Serial In-Serial Out, Serial In-Parallel Out, Parallel In- Parallel Out, Parallel In- Serial Out, Universal Shift Register, Application of Shift Registers. **Counter:** Asynchronous Counter, Decoding Gates, Synchronous Counters, Changing the Counter Modulus, Decade Counter, Presettable Counter, Designing of Asynchronous and Synchronous Counters	**10**
Unit – V	**Design of Synchronous and Asynchronous Sequential Circuit:** Design of Synchronous Sequential circuit: Model Selection, State Transition Diagram, State Synthesis Table, Design Equations and Circuit Diagram,	**8**

	Implementation using Read Only Memory, State Reduction Table and ASM Chart. **Design of Asynchronous Sequential Circuit:** Analysis of Asynchronous Sequential Circuit, Problems with Asynchronous Sequential Circuit, Circuit Designing, Case study - ORCAD	
	Total	**46**

Text Book:

1. Donald P Leach, Albert Paul Malvino& Goutam Saha, "Digital Principle and Application," 7th Edition, Tata McGraw Hill, 2010
2. Mano M. Morris and Ciletti M.D., "Digital Design," Pearson Education 4th Edition.

Reference Books:

1. Charles H. Roth,"Fundamentals of Logic Design,Jr.," 5th Edition, Thomson, 2004
2. Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss,"Digital Systems Principles and Applications," 10th Edition, Pearson Education, 2007

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 302 Course Title: **Data Structures with C**
2. Contact Hours: L: 3 T: - P: -
3. Semester: III

4. Pre-requisite: Good Knowledge of Programming in C (TCS 101, TCS 201)

5. Course Outcomes: After completion of the course students will be able to

1. Describe the concept of Data Structures and assess how the choice of data structures impacts the performance of programs
2. Compare and contrast merits and demerits of various data structures in terms of time and memory complexity.
3. Identify and propose appropriate data structure for providing the solution to the real world problems.
4. Implement operations like searching, insertion, deletion, traversing mechanism etc. on various data structures
5. Be familiar with advanced data structures such as balanced search trees, hash tables, AVL trees, priority queues, ADT etc.
6. To augment merits of particular data structures on other data structure to develop innovation in subject of study.

6. Details of Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	**Introduction:** Basic Terminology, Pointer and dynamic memory allocation, Elementary Data Organization, Data Structure operations, Algorithm Complexity and Time-Space trade-off Arrays**:** Array Definition, Representation and Analysis, Single and Multidimensional Arrays, address calculation, application of arrays, Array as Parameters, Ordered List, Sparse Matrices. Stacks:Array. Representation and Implementation of stack, Operations on Stacks: Push & Pop, Array Representation of Stack, Linked Representation of Stack, Operations Associated with Stacks, Application of stack: Conversion of Infix to Prefix and Postfix Expressions, Evaluation of postfix expression using stack. Recursion: **Recursive** definition and processes, recursion in C, example of recursion, Tower of Hanoi Problem, tail recursion.	**10**
Unit - II	**Queues:** Array and linked representation and implementation of queues, Operations on Queue: Create, Add, Delete, Full and Empty. Circular queue, Dequeue, and Priority Queue**.** **Linked list**: Representation and Implementation of Singly Linked Lists, Two-way Header List, Traversing and Searching of Linked List, Overflow and Underflow, Insertion and deletion to/from Linked Lists, Insertion and deletion Algorithms, Doubly linked list, Linked List in Array, Polynomial representation and addition, Generalized linked list.	**10**
Unit – III	**Trees**: Basic terminology, Binary Trees, Binary tree representation, algebraic Expressions, Complete Binary Tree. Extended Binary Trees, Array and Linked Representation of Binary trees, Traversing Binary trees, Threaded Binary trees. Traversing Threaded Binary trees, Huffman algorithm & Huffman tree**.** **Searching and Hashing**: Sequential search, binary search, comparison and analysis, Hash Table, Hash Functions, Collision Resolution Strategies, Hash Table Implementation	**9**

Unit – IV	***Sorting**:* Insertion Sort, Bubble Sorting, Quick Sort, Two Way Merge Sort, Heap Sort, Sorting on Different Keys, Practical consideration for Internal Sorting. **Binary Search Trees**: Binary Search Tree (BST), Insertion and Deletion in BST, Complexity of Search Algorithm, Path Length, AVL Trees	**9**
Unit – V	**File Structures**: Physical Storage Media File Organization, Organization of records into Blocks, Sequential Files, Indexing and Hashing, Primary indices, Secondary indices, B+ Tree index Files, B Tree index Files, Indexing and Hashing Comparisons, Graph, Traversal(DFS,BFS) ,Minimum spanning tree	**8**
	Total	**46**

Text/ Reference Books:

1. Horowitz and Sahani, “Fundamentals of data Structures”, Galgotia Publication Pvt. Ltd., New Delhi.
2. R. Kruse etal, “Data Structures and Program Design in C”, Pearson Education Asia, Delhi-2002
3. A. M. Tenenbaum, “Data Structures using C & C++”, Prentice-Hall of India Pvt. Ltd., New Delhi.
4. K Loudon, “Mastering Algorithms with C”, Shroff Publisher & Distributors Pvt. Ltd.
5. Bruno R Preiss, “Data Structures and Algorithms with Object Oriented Design Pattern in C++”, Jhon Wiley & Sons, Inc.
6. Adam Drozdek, “Data Structures and Algorithms in C++”, Thomson Asia Pvt

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 307 Course Title: **Object Oriented Programming with C++**
2. Contact Hours: L: 3 T: - P: -
3. Semester: III

4. Pre-requisite: TCS 101, TCS 201

5. Course Outcomes: After completion of the course students will be able to

1. Demonstrate the C++ Program uses data types, operators, expressions, array, strings and functions.
2. Implement Constructors (Parameterized, Copy), this pointer, friend function, dynamic objects, arrays of objects,
3. Illustrate the Operator Overloading of +, -, preincrement, postincrement, << and >>.
4. Implement the single, multiple, multilevel and hybrid inheritance in C++.
5. Illustrate function overloading, Overriding and virtual functions.
6. Carry out exception handling techniques and provide solutions to storage related problems using STL.

6. Details of Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	**Introduction:** Need of object oriented programming, Overview of C++,Header Files and Namespaces, Sample C++ program, Different data types, operators, expressions, and statements, arrays and strings, pointers & user-defined types Function Components, argument passing ,inline functions, recursive functions.	**10**
Unit - II	**Classes & Objects:** Class Specification, Objects, Scope resolution operator, Access members, Defining member functions, Data hiding, Constructors , Parameterized constructors, Destructors, Static data members, Friend functions, Passing objects as arguments, Returning objects, Arrays of objects, Dynamic objects, Pointers to objects, Copy constructors, This Pointer **Operator overloading** :Fundamentals of Operator Overloading, Overloading Binary Operators and unary operators, Operator overloading using friend functions such as +, - , pre-increment, post-increment, overloading of << and >>.	**9**
Unit – III	**Inheritance:** Necessity of inheritance, Types of inheritance with examples**,** Base Class and Derived class, Public, private and protected access modifiers, Inheriting multiple base classes ,working of Constructors and	**9**

	Destructors in Inheritance, Passing parameters to base class constructors, Virtual base classes	
Unit – IV	**Virtual functions and Polymorphism:** Polymorphism, function overloading, Overriding Methods, Virtual function, Calling a Virtual function through a base class reference, Pure virtual functions, Abstract classes, Virtual Destructors ,Early and late binding.	**9**
Unit – V	I/O System Basics and STL: C++ stream classes, I/O manipulators, fstream and the File classes, basic file operations, function templates Exception Handling: Exception handling fundamentals, Throwing an Exception, Catching an Exception, Re-throwing an Exception, An exception example, STL: An overview, containers, vectors, lists, maps, Algorithms	**9**
	Total	**46**

Text Books:

1. Herbert Schildt: "The Complete Reference C++", 4th Edition, Tata McGraw Hill, 2003.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 331 Course Title: **Fundamental of IoT**
2. Contact Hours: L: 3 T: 1 P: -
3. Semester: III

4. Pre-requisite: Fundamentals of Computer and any Programming Language

5. Course Outcomes: After completion of the course students will be able to

1. Explain the terms used in IoT.
2. Describe key technologies in Internet of Things.
3. Identify components needed to provide a solution for certain applications.
4. Analyze security requirements in an IoT system.
5. Design wireless sensor network architecture and its framework along with WSN applications.
6. Understand business models for the Internet of Things.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	**INTRODUCTION** Introduction to Internet of Things: History of IoT, About IoT, Overview and Motivations, Examples of Applications, Internet of Things Definitions and Frameworks: IoT Definitions, IoT Architecture, General Observations, ITU-T Views, Working Definition, IoT Frameworks, Basic Nodal Capabilities.	**8**
Unit - II	**FUNDAMENTAL IoT MECHANISMS AND KEY TECHNOLOGIES** Identification of IoT Objects and Services, Structural Aspects of the IoT, Environment Characteristics, Traffic Characteristics, Scalability, Interoperability, Security and Privacy, Open Architecture, Key IoT Technologies, Device Intelligence, Communication Capabilities, Mobility Support, Device Power, Sensor Technology, RFID Technology, Satellite Technology.	**10**
Unit – III	**RADIO FREQUENCY IDENTIFICATION TECHNOLOGY** RFID: Introduction, Principle of RFID, Components of an RFID system, Issues EPCGlobal Architecture Framework: EPCIS & ONS, Design issues, Technological challenges, Security challenges, IP for IoT, Web of Things. Wireless Sensor Networks: History and context, WSN Architecture, the node, Connecting nodes, Networking Nodes, Securing Communication WSN specific IoT applications, challenges: Security, QoS, Configuration, Various integration approaches, Data link layer protocols, routing protocols and infrastructure establishment.	**10**
Unit – IV	**RESOURCE MANAGEMENT IN THE INTERNET OF THINGS** Clustering, Software Agents, Clustering Principles in an Internet of Things Architecture, Design Guidelines, and Software Agents for Object Representation, Data Synchronization. Identity portrayal, Identity management, various identity management models: Local, Network, Federated and global web identity, user-centric identity management, device centric identity management and hybrid-identity management, Identity and trust.	**10**
Unit – V	**INTERNET OF THINGS PRIVACY, SECURITY AND GOVERNANCE** Vulnerabilities of IoT, Security requirements, Threat analysis, Use cases and misuse cases, IoT security tomography and layered attacker model, Identity establishment, Access control, Message integrity, Non-repudiation and availability, Security model for IoT.	**10**

	Internet of Things Application: Smart Metering Advanced Metering Infrastructure, e-Health Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards.	
	Total	**48**

Text Books

1. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications

2. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3- 642-19156-5 e-ISBN 978-3-642-19157-2, Springer

3. Parikshit N. Mahalle&Poonam N. Railkar, "Identity Management for Internet of Things", River Publishers, ISBN: 978-87-93102-90-3 (Hard Copy), 978-87-93102-91-0 (ebook).

Reference Books

1. HakimaChaouchi, "The Internet of Things Connecting Objects to the Web" ISBN : 978-1- 84821-140-7, Willy Publications

2. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, ISBN: 978-1-119-99435-0, 2 nd Edition, Willy Publications

3. Daniel Kellmereit, Daniel Obodovski, "The Silent Intelligence: The Internet of Things",. Publisher: Lightning Source Inc; 1 edition (15 April 2014). ISBN-10: 0989973700, ISBN-13: 978- 0989973700.

4. Fang Zhaho, Leonidas Guibas, "Wireless Sensor Network: An information processing approach", Elsevier, ISBN: 978-81-8147-642-5.

Name of Department:- Computer Science and Engineering

1. Subject Code: TMA 316 Course Title: **Discrete Structures and Combinatorics**
2. Contact Hours: L: 3 T: 1 P: 0
3. Semester: III

4. Pre-requisite: TMA 101, TMA 201

5. Course Outcomes: After completion of the course students will be able to

1. Specify and manipulate basic mathematical objects such as sets, functions, and relations. Demonstrate partial order relations and Lattices.
2. Apply the discrete probability and number theory to solve the engineering problems.
3. Produce convincing arguments, conceive and/or analyze basic mathematical proofs and discriminate between valid and unreliable arguments.
4. Discriminate, identify and prove the properties of groups and subgroups
5. Apply the basic counting techniques to solve combinatorial problems
6. Demonstrate different traversal methods for trees and graphs. Model problems in Computer Science using graphs and trees.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**Relations and Functions:** Review of Sets, Relations - properties, equivalence relation, matrix and Graph representation, Closure operations Functions, Types of functions, Invertability, Composition of functions and Inverse functions, Partially ordered Sets and Lattices. Lattice Properties, Lattices as Boolean Algebra	**11**
Unit – II	**Probability Theory** Basics of Probability, Conditional Probability; Random Variables, probability mass and density function, commutative distribution function, expected values, mean, variance and standard deviation, Distributions: Binomial. Poisson, normal, uniform,, exponential,	**9**
Unit – III	**Fundamentals of Logic:** Basic Connectives and Truth Tables, Logical Equivalence – The Laws of Logic, Logical Implication – Rules of Inference. The Use of Quantifiers, **Methods of Proof:** Different methods of proof – Direct Proof, Indirect Proof, Counter examples, Principle of Induction.	**9**
Unit – IV	**Groups:** Definitions, Examples, and Elementary Properties, Homomorphism, Isomorphism, permutation groups and cyclic Groups, subgroups, cosets, and Lagrange's Theorem **Counting:** Set cardinality and counting, Sum and Product Rules, Inclusion Exclusion Principles, Pigeonhole principle, permutations and combinations, Basics of recurrence relations and, generating Functions	**10**
Unit – V	**Graphs and Trees** Fundamentals of Graphs Graph types – undirected, directed, weighted; - Representing graphs and graph isomorphism -connectivity-Euler and Hamilton paths, Isomorphism Tree properties, traversal techniques;	**9**
	Total	**48**

Text Books:

1. Kenneth H. Rosen:" Discrete Mathematics and its Applications", 6th Edition, McGraw Hill, 2007.
2. Jayant Ganguly:" A Treatise on Discrete Mathematical Structures", Sanguine-Pearson, 2010.

Reference Books:

1. D.S. Malik and M.K. Sen: "Discrete Mathematical Structures: Theory and Applications", Thomson, 2004.
2. Thomas Koshy: "Discrete Mathematics with Applications", Elsevier, 2005, Reprint 2008.
3.Ralph P. Grimaldi: "Discrete and Combinatorial Mathematics", 5th Edition, Pearson Education, 2004.
4. S.B.Singh, Jaikishor and Ekata, "Discrete Mathematics", Khanna Publication, 2011.

Name of Department: - Computer Science and Engineering

1. Subject Code: TMA 402 Course Title: **Computer Based Numerical and Statistical Technique**
2. Contact Hours: L: 3 T: - P: -
3. Semester: IV

4. Pre-requisite: TMA 101, TMA 201, TCS 101, TCS 201

5. Course Outcomes: After completion of the course students will be able to

1. Develop the notion of errors, finding of errors, roots and apply them in problem solving in concern subject.
2. Use effectively interpolation techniques and use them for numerical differentiation and integration.
3. Interpret asymptotic notation, its significance, and be able to use it to analyse asymptotic performance for basic algorithmic examples.
4. Examine statistical control techniques and be able to relate these to practical examples.
5. Elaborate the basics of regression, curve fitting and be able to apply the methods from these subjects in problem solving.
6. Explain the concepts of numerical solutions of ordinary differential equations.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	**Introduction:** Numbers and their accuracy, Computer Arithmetic, Mathematical preliminaries, Errors and their Computation, General error formula, Error in series approximations. **Solution of Algebraic and Transcendental Equation:** Bisection Method, Iteration method, Method of false position, Newton-Raphson method, Rate of convergence of Iterative methods. **Solution of system of linear equations:** Gauss Elimination method, Gauss Jordan method and Gauss Seidel method.	**10**
Unit - II	**Interpolation:** Finite Differences, Difference tables, Polynomial Interpolation: Newton's forward and backward formula, Central difference formulae: Gauss forward and backward formula, Stirling's, Bessel's, Everett's formula. Interpolation with unequal intervals: Lagrange's interpolation, Newton divided difference formula.	**10**
Unit – III	**Numerical Differentiation and Integration:** Introduction, Numerical differentiation Numerical Integration: Trapezoidal rule, Simpson's 1/3 and 3/8 rule, Weddle's rule	**9**
Unit – IV	**Numerical Solution of differential Equations:** Taylor's Method, Picard's Method, Euler's and modified Euler's method, Runge-Kutta Method, Milne's Predictor Corrector Method	**9**
Unit – V	**Statistical Computation:** Frequency charts, Curve fitting by method of least squares, fitting of straight lines, polynomials, exponential curves etc, Data fitting with Cubic splines, Regression Analysis, Linear, Non linear Regression and Multiple regression	**10**
	Total	**48**

Text Books:

- Rajaraman V, "Computer Oriented Numerical Methods", Pearson Education, 2000.

- Grewal B S, “Numerical methods in Engineering and Science”, Khanna Publishers, Delhi, 2005.

Reference Books:

- Goyal, M, “Computer Based Numerical and Statistical Techniques”, Laxmi Publication (P) Ltd., New Delhi, 2005.
- Jain, Iyengar and Jain, “Numerical Methods for Scientific and Engineering Computations”, New Age Int, 2003.
- T Veerarajan, T Ramachandran, “Theory and Problems in Numerical Methods, TM, 2004.
- Francis Scheld, “Numerical Analysis”, TMH, 2010.
- Sastry, S. S, “Introductory Methods of Numerical Analysis”, Pearson Education, 2009.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 402 Course Title: **Finite Automata and Formal Languages**
2. Contact Hours: L: 3 T: 1 P: 0
3. Semester: IV

4. Pre-requisite: TMA 101, TMA 201

5. Course Outcomes: After completion of the course students will be able to

1. Demonstrate the conversion of NFA into DFA, ϵ-NFA into DFA and Minimization of Finite Automata by using Myhill-Nerode Theorem
2. Formulate DFA, RE and FA with output.
3. Design CFG and check the language is not CFL.
4. Design PDA and convert n-PDA into d-PDA.
5. Design Turing machines for addition, substraction, multiplication etc.
6. Formulate finite machines, push down automata and Turing machines for automated functioning of devices.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	Introduction; Alphabets, Strings and Languages; Automata and Grammars, Deterministic finite Automata (DFA)-Formal Definition, Simplified notation: State transition graph, Transition table, Language of DFA, Nondeterministic finite Automata (NFA), NFA with epsilon transition, Language of NFA, Equivalence of NFA and DFA, Minimization of Finite Automata, Distinguishing one string from other, Myhill-Nerode Theorem	**10**
Unit - II	Regular expression (RE), Definition, Operators of regular expression and their precedence, Algebraic laws for Regular expressions, Kleen's Theorem, Regular expression to FA, DFA to Regular expression, Arden Theorem, Non Regular Languages, Pumping Lemma for regular Languages. Application of Pumping Lemma, Closure properties of Regular Languages, Decision properties of Regular Languages, FA with output: Moore and Mealy machine, Equivalence of Moore and Mealy Machine, Applications and Limitation of FA.	**10**
Unit – III	Context free grammar (CFG) and Context Free Languages (CFL): Definition, Examples, Derivation, Derivation trees, Ambiguity in Grammar, Inherent ambiguity, Ambiguous to Unambiguous CFG, Useless symbols, Simplification of CFGs, Normal forms for CFGs: CNF and GNF, Closure proper ties of CFLs, Decision Properties of CFLs: Emptiness, Finiteness and Membership, Pumping lemma for CFLs.	**9**
Unit – IV	Push Down Automata (PDA): Description and definition, Instantaneous Description, Language of PDA, Acceptance by Final state, Acceptance by empty stack, Deterministic PDA, Equivalence of PDA and CFG, CFG to PDA and PDA to CFG, Two stack PDA.	**10**
Unit – V	Turing machines (TM): Basic model, definition and representation, Instantaneous Description, Language acceptance by TM, Variants of Turing Machine, TM as Computer of Integer functions, Universal TM, Church's Thesis, Recursive and recursively enumerable languages, Halting problem, Introduction to Undecidability, Undecidable problems about TMs. Post	**8**

	correspondence problem (PCP), Modified PCP, Introduction to recursive function theory.	
	Total	**47**

Text Book:

- Hopcroft, Ullman, “Introduction to Automata Theory, Languages and Computation”, Pearson Education.
- KLP Mishra and N. Chandrasekaran, “Theory of Computer Science: Automata, Languages and Computation”, PHI Learning Private Limited, Delhi India.

Reference Books:

- Michael Sipser,” Introduction to Theory of Computation”, (2nd edition), Thomson, 2006
- Peter Linz, "An Introduction to Formal Language and Automata", Narosa Publishing house.
- Elaine Rich , “Automata, Computability, Complexity-Theory and applications”

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 403 Course Title: **Microprocessors**

2. Contact Hours: L: 3 T: - P: -

3. Semester: IV

4. Pre-requisite: TEC 101, TEC 201, TCS 101, TCS 301

5. Course Outcomes: After completion of the course students will be able to

1. Understanding of 8085 and 8086 microprocessors and memory segmentation
2. Analysis of Instruction set of 8085and 8086.
3. Implementation of different programs on 8085 and 8086 based microcomputer kit.
4. Interfacing of 8255 and 8085/8086.
5. Interfacing of microprocessor with Timing Devices
6. This course will act as foundation for projects based on Embedded system and interfacing of different ICs

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	Introduction to Microprocessors: Evolution of Microprocessors, Classification-Brief Evolution, Example of an 8085 based System, Microprocessor Internal Architecture, hardware model of 8085, Pin diagram and function of each pin, memory interfacing.	**9**
Unit - II	Programming with 8085: Instruction set, programming model of 8085, addressing modes, assembly language programming, Timing and control, peripheral I/O, memory mapped I/O, 8085 Interrupts, Stack and subroutines.	**10**
Unit – III	16 Bit Processor: 16-bit Microprocessors (8086): Architecture, pin diagram, Physical address, segmentation, memory organization, Bus cycle, Addressing modes, Instruction set ,Assembly Language Programming of 8086, comparison of 8086 & 8088	**8**
Unit – IV	Interfacing (Data Transfer) with Microprocessor: Data Transfer Schemes: Introduction, handshaking signals, Types of transmission, 8255 (PPI), Serial Data transfer (USART 8251), memory interfacing, 8257 (DMA), programmable interrupt Controller (8259).	**8**
Unit – V	Interfacing of Microprocessor with Timing Devices: Programmable Interval Timer/ Counter (8253/8254): Introduction, modes, Interfacing of 8253, applications. Introduction to DAC & ADC, ADC & DAC Interfacing (0808, 0809).	**9**
	Total	**44**

Text Book:

1. Ramesh Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, 5th Edition, Penram International Publication (India) Pvt. Ltd.
2. Douglas V. Hall, “Microprocessors and Interfacing”, 2nd Edition, TMH, 2006.

Reference Book:

1. Kenneth L. Short, “Microprocessors and programmed Logic”, 2nd Ed, Pearson Education Inc.

2. A.K.Ray&K.M.Bhurchandi, “Advanced Microprocessors and peripherals” , Tata McGraw Hill, 2000.2nd edition

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 404 Course Title: **Computer Organization**
2. Contact Hours: L: 3 T: 1 P: 0
3. Semester: IV

4. Pre-requisite: Fundamentals of Computer System, TCS301

5. Course Outcomes: After completion of the course students will be able to

1. Understand the basic components of a computer and milestones in their historical development.
2. Discuss the operation of the arithmetic unit including the algorithms & implementation of fixed-point and floating-point addition, subtraction, multiplication & division.
3. Have a clear understanding of the elements of CPU working and Instruction Set Architecture
4. Identify the impact of the hierarchical memory system including cache memories and virtual on the overall computer system design
5. Evaluate the various aspects I/O operations and their impact on the overall performance and functioning of computers
6. Review the current trends in development of processor architectures with emphasis on instruction level parallelism, latency operations in pipeline design, fault tolerance etc.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	**Introduction:** The main components of a Computer, Historical Development: First through Fourth Generation Computers, Moore's Law, The Von Neumann and Non Von Neumann Model, The Evolution of the Intel x86 Architecture **Data Representation in Computer Systems:** Signed Integer Representation, Complement Systems: One's complement and Two's complement, Addition and Subtraction using signed numbers, Multiplication of Positive Numbers, Signed Operand Multiplication, Integer Division; Floating Point Representation, , The IEEE-754 Floating Point Standard,Floating Point Arithmetic, Floating Point Errors	**10**
Unit - II	**Machine Instructions and Programs:** Memory Location and Addresses, Memory Operations, Instructions and Instruction Sequencing, Addressing Modes, , Execution of a Complete Instruction, Single Bus Organization, Control Unit Operations: Instruction sequencing, Micro operations and Register Transfer. Hardwired Control, Micro-programmed Control: Basic concepts, Microinstructions and micro-program sequencing **Performance** – Processor Clock, Basic Performance Equation, Clock Rate, Performance Measurement Concept of Pipelining, Amdahl's Law	**12**
Unit – III	**Input/Output Organization:** Accessing I/O Devices, Interrupts – Interrupt Hardware, Enabling and Disabling Interrupts, Handling Multiple Devices, Controlling Device Requests, Exceptions, Direct Memory Access, Buses Interface Circuits, Standard I/O Interfaces – PCI Bus, SCSI Bus, USB	**9**
Unit – IV	**Memory System:** Basic Concepts, Types of Memory, Speed, Size, and Cost, The Memory Hierarchy, Locality of Reference, Cache Memories – Mapping Functions, Replacement Algorithms, Effective Access Time and Hit Ratio, Virtual Memory-Paging, Advantages and Disadvantages of Paging and Virtual	**9**

	Memory, Segmentation, Paging Combined with Segmentation, Real World Example of Memory Management-Pentium 4 Memory Management	
Unit – V	**Introduction to Alternative Architectures:** RISC Machines, Flynn's Taxonomy, Parallel and Multiprocessor Architectures: Instruction level pipelining,Superscalar and VLIW, Vector Processors, Interconnection Networks, Shared Memory Multiprocessors, Closely and Loosely coupled multiprocessors systems; Alternative Parallel Processing Approaches: Dataflow Computing, Neural Networks.	**8**
	Total	**48**

Text Books:

- William Stallings:" Computer Organization & Architecture", 8th Edition, PHI, 2010.
- Carl Hamacher, ZvonkoVranesic, SafwatZaky:" Computer Organization", 5th Edition, Tata McGraw Hill, 2002.

Reference Books:

- David A. Patterson, John L. Hennessy: "Computer Organization and Design – The Hardware / Software Interface ARM Edition", 4th Edition, Elsevier
- Linda Null, Julia Lobur: "Computer Organization and Architecture", Jones and Bartlett Publishers, 2003 Edition

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 408 Course Title: **Java Programming Language**
2. Contact Hours: L: 3 T: - P: -
3. Semester: IV

4. Pre-requisite: TCS 101, TCS 201, TCS 302, TCS 307

5. Course Outcomes: After completion of the course students should be able to

1. Explain the Java programming features and develop programs to demonstrate the same.
2. Make use of object oriented concepts to develop applications
3. Classify exceptions and demonstrate applications for file handling and multithreading.
4. Analyze collection framework and develop applications using GUI.
5. Compare and utilize collection framework for programming applications
6. Design applications for event handling and accessing databases using Java features.

Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	**Introduction to Java :**Importance and features of Java, Concepts of Java Virtual machine (JVM) Keywords, Constants, Variables and data types, operators and expressions, Control statements, Conditional statements, loops and iterations, Wrapper classes, Scanner Class: Scanner class methods (next(),nextLine() etc. **Concept of class:** Class definition, adding variables and methods, creating objects, constructors, defining methods, calling methods, Arrays,String Handling in java(String, StringBuffer classes)	**10**
Unit - II	**Object Oriented Programming concepts:** Inheritance, super classes, multilevel hierarchy, abstract and final classes, overloading and overriding **Packages and interfaces**: Packages, Defining Packages, Using Packages, import and static import, Access protection. **Interface:** Defining Interfaces, abstract methods declarations, implementing interfaces, extended interfaces, interface references.	**9**
Unit – III	**Exception handling:** Exception Types, Exception class, RuntimeException Class, Error Class, Checked and uncheced Exceptions, Defining new exceptions; Handling: try, catch and finally; throw statement, throws clause. **Input/Output:**Basics, Byte and Character Streams, reading and writing from console and file. **Multithreaded programming:** Java thread model, synchronization, messaging, thread class, Runnable interface, inter thread communication, Producer/ consumer problems, Wait () and notify ().	**9**

Unit – IV	**Collection and Generic Framework:** Introduction to Collection and Generic Framework: Interfaces Iterator, List, Set, ArrayList, LinkedList HashSet and ArrayDeque classes **AWT & Swing:** Introduction to AWT and Swings, Swings advantages over AWT, Swing applications, Swing Controls : JButton ,JLabel , JCheckBox , JRadioButton , JList , JComboBox, JTextFiled, JTextArea , JScrollBar, JTable, Graphics in swing	**9**
Unit – V	**Event Handling:**Event delegation model, classes, Event Listener Interfaces, Adapter classes. **Java Database Connectivity (JDBC):**The Concept of JDBC, JBDC drivers(Type1 Driver,Type4 Driver), Connection interface, Statement interface, ResultSet interface, Creating and executing SQL statements.	**9**
	Total	**46**

Text books:

1. Patrick Naughton and Herbert Schildt, "Java 2 The Complete Reference", 9th edition, McGraw Hill Education, 2017.
2. Bruce Eckel, "Thinking in Java", 4th edition,Pearson Education India, 2008
3. E. Balaguruswamy, "Programming with Java a Primer", 4thedition, Tata McGraw Hill, 2009.

Reference Books:

1. Cay S Horstmann and Gary Cornell, "Core Java Volume –I and II", Standard edition, Sun Microsystems, 2001
2. Harvey Deitel and Paul Deitel, "Java How to Program" , 4thedition, PHI Learning, 2004

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 433** Course Title: BLOCKCHAIN TECHNOLOGY AND ITS APPLICATIONS
2. Contact Hours: L: 3 T: 1 P:
3. Semester: IV

4. Pre-requisite: Introduction to cryptography, network and system security

5. Course Outcomes: After completion of the course students will be able to

1. Explain blockchain technology and its immutable property
2. Know the working of distributed ledger
3. Analyse the different consensus protocols
4. Use Ethereum to implement Blockchain
5. Apply blockchain techniques in different applications
6. Evaluate the state of the art and emerging use cases of blockchain.

7. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	INTRODUCTION TO BLOCKCHAIN- Overview of blockchain, structure of a block, block header, block identifiers: block header hash and block height, genesis block, linking of blocks, merkle trees, and use of merkle root in payment verification	**10**
Unit - II	APPLICATION OF CRYPTOGRAPHY TO BLOCKCHAIN- Overview of ECDSA, DSA and RSADS, use of hash functions to chain blocks, use of digital signatures to sign transactions	**9**
Unit – III	DISTRIBUTED LEDGER- Introduction to distributed systems, fault tolerance and paxos, byzantine agreement, authenticated agreement, eventual consistency & bitcoin consistency- availability and partitions, bitcoin, smart contracts, weak consistency, distributed storage, consistent hashing mechanism	**8**
Unit – IV	MINING AND CONSENSUS – Overview of various consensus algorithms, decentralized consensus, independent verification of transactions, mining nodes, aggregating transactions into blocks, constructing the block header, successfully mining of block, validating a new block, assembling and selecting chains of blocks, consensus attacks, DoS attack on blockchain, changing the consensus rules, soft fork signaling with block version	**10**
Unit – V	ETHEREUM- Differences between ethereum and bitcoin, block format, mining algorithm, proof-of-stake (PoS) algorithm, account management, contracts and transactions, decentralized applications using ethereum proof-of-stake (PoS) algorithm, contracts and transactions. APPLICATIONS OF BLOCKCHAIN TECHNOLOGY:	**8**

	Blockchain in banking and marketing, smart contracts, blockchain of Internet of Things, blockchain in healthcare, Future Research directions of blockchain technology.	
	Total	**45**

Text Books:

- George Icahn, "Blockchain: the complete guide to understanding blockchain technology", 2020.
- Antony lewis, "The basics of bitcoins and blockchains: an introduction to cryptocurrencies and the technology that powers them" 2020.

Reference Books:

- Andreas M. Antonopoulos, "Mastering Bitcoin: unlocking digital cryptocurrencies", O'Reilly Media,(2e) 2017.
- Roger Wattenhofer, "Distributed Ledger Tehnology, The science of the Blockchain", Inverted Forest Publishing,(2e), 2017
- Antonopoulos, Andreas M. and Wood, Gavin. Mastering Ethereum. O'Reilly Media, 2018.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 501 Course Title: **System Software**
2. Contact Hours: L: 3 T: 1 P: 0
3. Semester: V

4. Pre-requisite: TCS 301, TCS 403, TCS 307

5. Course Outcomes: After completion of the course students will be able to

1. Define system software and differentiate system software with other softwares.
2. Assess the working of Assembler, Loader/Linker and Macroprocessor.
3. Understand the concept of passes in translators.
4. Determine the purpose of linking, and types of linking.
5. Develop the system software according to machine limitations.
6. Compare and Contrast the various text editors.

7. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	**Machine Architecture:** Introduction, System Software and its relation to Machine Architecture, Simplified Instructional Computer (SIC), Architecture of SIC Machine , SIC Programming Examples	**9**
Unit - II	**Assemblers:** Basic Assembler Functions, A Simple SIC Assembler, Algorithm and Data Structures for Assemblers, Machine Dependent Assembler Features - Instruction Formats & Addressing Modes, Program Relocation. Machine Independent Assembler Features – Literals, Symbol-Definition Statements, Expression, Program Blocks, Control Sections and Programming Linking, Assembler Design Operations - One-Pass Assembler, Multi-Pass Assembler	**9**
Unit – III	**Loaders and Linkers:** Basic Loader Functions - Design of an Absolute Loader, A Simple Bootstrap Loader, Machine-Dependent Loader Features – Relocation, Program Linking, Algorithm and Data Structures for a Linking Loader; Machine-Independent Loader Features - Automatic Library Search, Loader Options, Loader Design Options - Linkage Editor, Dynamic Linkage, Bootstrap Loaders **Editors and Debugging Systems:** Text Editors - Overview of Editing Process, User Interface, Editor Structure, Interactive Debugging Systems - Debugging Functions and Capabilities, Relationship With Other Parts Of The System, User-Interface Criteria	**10**
Unit – IV	**Macro Processor:** Basic Macro Processor Functions - Macro Definitions and Expansion, Macro Processor Algorithm and Data Structures, Machine-Independent Macro Processor Features - Concatenation of Macro Parameters, Generation of Unique Labels, Conditional Macro Expansion, Keyword Macro Parameters, Macro Processor Design Options, General-Purpose Macro Processors, Macro Processing Within Language Translators	**8**
Unit – V	**Lex and Yacc :**Lex and Yacc - The Simplest Lex Program, Recognizing Words With LEX, Symbol Tables, Grammars, Parser-Lexer Communication, The Parts of Speech Lexer, A YACC Parser, The Rules Section, Running LEX and YACC, LEX and Hand- Written Lexers, Using LEX - Regular Expression,	**10**

	Examples of Regular Expressions, A Word Counting Program, Parsing a Command Line. Using YACC – Grammars, Recursive Rules, Shift/Reduce Parsing, What YACC Cannot Parse, A YACC Parser - The Definition Section, The Rules Section, Symbol Values and Actions, The LEXER, Compiling and Running a Simple Parser, Arithmetic Expressions and Ambiguity, Variables and Typed Tokens.	
	Total	**46**

Text/ Reference Books:

1. Leland.L.Beck: " System Software: an introduction to systems programming", 3rd Edition, Addison-Wesley, 1997.
2. John.R.Levine," Tony Mason and Doug Brown: Lex and Yacc", O'Reilly, SPD, 1998.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 502 Course Title: **Operating Systems**
2. Contact Hours: L: 3 T: - P: -
3. Semester: V

4. Pre-requisite: TCS 301, TCS 403, TCS 404

5. Course Outcomes: After completion of the course students will be able to

1. Understand the concept and design issues associated with an operating system
2. Identify the problems related to process management and synchronization and apply learned methods to solve basic problems
3. Explain the basics of memory management and the use of virtual memory in modern operating systems.
4. Understand the concept deadlock avoidance, prevention and detections techniques.
5. Implementation of process management, memory management and file management using system calls.
6. Analyze the data structures and algorithms used for developing an operating systems

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	**Introduction to Operating Systems, UNIX:** What operating systems do; Operating System structure; Operating System Services; User - Operating System interface; System calls; Types of system calls; System programs; Operating System structure; Unix command: Command Structure, Internal and External commands, filters; vi editor.	8
Unit - II	**Process Management:** Process concept; Process scheduling; Operations on processes; Multi-Threaded Programming: Overview; Multithreading models; Threading issues. Process Scheduling: Basic concepts; Scheduling criteria; Scheduling algorithms; Multiple-Processor scheduling; Thread scheduling. **Process Synchronization:** Inter-process communication; Synchronization: The Critical section problem; Peterson's solution; Synchronization hardware; Semaphores; Classical problems of synchronization.	10
Unit – III	**Deadlocks:** Deadlocks: System model; Deadlock characterization; Methods for handling deadlocks; Deadlock prevention; Deadlock avoidance; Deadlock detection and recovery from deadlock. **Memory Management:** Memory Management Strategies: Background; Swapping; Contiguous memory allocation; Paging; Structure of page table; Segmentation. Virtual Memory Management: Background; Demand paging; Page replacement; Allocation of frames; Thrashing.	10
Unit – IV	**File System, Implementation of File System:** File System:File concept; Access methods; Directory structure; File system mounting; File sharing; Protection. Implementing File System: File system structure; Directory implementation; Allocation methods; Free space management. **Secondary Storage Structures, Protection :** Mass storage structures; Disk structure; Disk scheduling; Disk management; Swap space management. Protection: Goals of protection, Principles of protection, Access matrix.	8

Unit – V	**Shell Programming:** Shell scripts, Running script in the current shell, Pattern Matching, Redirection, String handling, Conditional Parameter Substitution, Shell functions. **Case Study: The Linux Operating System:** Linux history; Design principles; Kernel modules; Process management; Scheduling; Memory management; File systems, Input and output; Inter-process communication.	8
	Total	**44**

Text Books:

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne:" Operating System Principles", 7th edition, Wiley India, 2006.
2. William Stallings: "Operating Systems: Internals and Design Principles", 6th edition, Pearson, 2009
3. Sumitabha Das ,"Unix concepts and applications"

Reference Books:

1. Andrew S Tanenbaum: "Operating Systems: Design and Implementation", 3rd edition, Prentice Hall, 2006
2. Stuart E. "Madnick, John Donovan: Operating Systems", Tata McGraw Hill, 2008

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 503 Course Title: **Data Base Management Systems**
2. Contact Hours: L: 3 T: - P: -
3. Semester: V

4. Pre-requisite: TCS 302, TCS 404

5. Course Outcomes: After completion of the course students will be able to

1. Understand the different issues involved in the design and implementation of a database system.
2. Study the physical and logical database designs, database modeling, relational, hierarchical, and network models
3. Understand and use data manipulation language to query, update, and manage a database
4. Develop an understanding of essential DBMS concepts such as: database security, integrity, concurrency,
5. Design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS.
6. Evaluate a business situation and designing & building a database applications

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	**Introduction:** An overview of DBMS; Advantages of using DBMS approach; Database systems vs File Systems, Database system concepts and architecture Data models, schemas and instances; Three-schema architecture and data independence; Database languages and interfaces; The database system environment; Centralized and client-server architectures; Classification of Database Management systems.	**9**
Unit - II	**Entity-Relationship Model:** Using High-Level Conceptual Data Models for Database Design; An Example Database Application; Entity Types, Entity Sets, Attributes and Keys; Relationship types, Relationship Sets, Roles and Structural Constraints; Weak Entity Types; Refining the ER Design; ER Diagrams, Naming Conventions and Design Issues; Relationship types of degree higher than two.	**9**
Unit – III	**Relational Model and Relational Algebra :** Relational Model Concepts; Relational Model Constraints and Relational Database Schemas; Update Operations, Transactions and dealing with constraint violations; Unary Relational Operations: SELECT and PROJECT; Relational Algebra Operations from Set Theory; Binary Relational Operations : JOIN and DIVISION; Additional Relational Operations; Examples of Queries in Relational Algebra; Relational Database Design Using ER- to-Relational Mapping. **SQL – 1:** SQL Data Definition and Data Types; Specifying basic constraints in SQL; Schema change statements in SQL; Basic queries in SQL; More complex SQL Queries.	**11**

	Insert, Delete and Update statements in SQL; Specifying constraints as Assertion and Trigger; Views (Virtual Tables) in SQL; Additional features of SQL; Database programming issues and techniques; Embedded SQL, Dynamic SQL; Database stored procedures.	
Unit – IV	**Database Design – 1:** Informal Design Guidelines for Relation Schemas; Functional Dependencies; Normal Forms Based on Primary Keys; General Definitions of Second and Third Normal Forms; Boyce-Codd Normal Form Properties of Relational Decompositions; Algorithms for Relational Database Schema Design; Multivalued Dependencies and Fourth Normal Form; Join Dependencies and Fifth Normal Form; Inclusion Dependencies; Other Dependencies and Normal Forms	**9**
Unit – V	**Transaction Management:** The ACID Properties; Transactions and Schedules; Concurrent Execution of Transactions; Lock- Based Concurrency Control; Performance of locking; Transaction support in SQL; Introduction to crash recovery; 2PL, Serializability and Recoverability; Lock 9Management; Log Files; Checkpointing; Recovering from a System Crash; Media Recovery	**9**
	Total	**47**

Text Books:

1. Elmasri and Navathe: "Fundamentals of Database Systems", 5th Edition, Pearson Education, 2007.
2. Raghu Ramakrishnan and Johannes Gehrke: " Database Management Systems", 3rd Edition, McGraw-Hill, 2003.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 510 Course Title: **Software Engineering**
2. Contact Hours: L: 3 T: - P: 0
3. Semester: V

4. Pre-requisite: Basics of Programming

5. Course Outcomes: After completion of the course students will be able to

1. Understand Software Development Life Cycle and importance of engineering the software.
2. Development of efficient software requirement specification for desired product.
3. Compare various software development methodologies ad conclude on their applicability in developing specific type of product.
4. Construct an efficient design specification document for attainment of user desired product.
5. Develop applications using the concepts of various phases of software development life cycle.
6. Study various software testing techniques and identify their relevance to developing a quality software.

7. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	Introduction:What is Software Engineering and its history, Software Crisis, Evolution of a Programming System Product, Characteristics of Software, Brooks' No Silver Bullet, Software Myths Software Development Life Cycles: Software Development Process, The Code-and-Fix model, The Waterfall model, The Evolutionary Model, The Incremental Implementation, Prototyping, The Spiral Model, Software Reuse, Critical Comparisons of SDLC models, An Introduction to Non-Traditional Software Development Process: Rational Unified Process, Rapid Application Development, Agile Development Process	**10**
Unit - II	**Requirements:** Importance of Requirement Analysis, User Needs, Software Features and Software Requirements, Classes of User Requirements: Enduring and Volatile; Sub phases of Requirement Analysis, Functional and Non-functional requirements; Barriers to Eliciting User Requirements, The software requirements document and SRS standards, Requirements Engineering, Case Study of SRS for a Real Time System Tools for Requirements Gathering: Document Flow Chart, Decision Table, Decision Tree; Structured Analysis: DFD, Data Dictionary, Introduction to non-traditional Requirements Analysis Tools: FSM, Statecharts and Petrinets;	**9**
Unit – III	**Software Design:** Goals of Good Software Design, Design Strategies and Methodologies, Data Oriented Software Design, Structured Design: Structure Chart, Coupling, Cohesion,, Modular Structure, Packaging; Object Oriented Design, Top-Down and Bottom-Up Approach, Design Patterns Software Measurement and Metrics: Various Size Oriented Measures: Halestead's Software Science, Function Point (FP) Based Measures, Cyclomatic Complexity Measures: Control Flow Graphs. **Development:** Selecting a Language, Coding Guidelines, Writing Code, Code Documentation	**8**
Unit – IV	**Testing:** Testing Objectives, Unit Testing, Integration Testing, Acceptance Testing, Regression Testing, Testing for Functionality and Testing for	**10**

	Performance, Top-Down and Bottom-Up Testing Strategies: Test Drivers and Test Stubs, Structural Testing (White Box Testing), Functional Testing (Black Box Testing), Test Data Suit Preparation, Alpha and Beta Testing of Products. Static Testing Strategies: Formal Technical Reviews (Peer Reviews), Walk Through, Code Inspection, Compliance with Design and Coding Standards, Automated Testing	
Unit – V	**Software Maintenance and Software Project Management**: Software as an Evolutionary Entity, Need for Maintenance, Categories of Maintenance:Preventive, Corrective and Perfective Maintenance, Cost of Maintenance, Software Re-Engineering, Reverse Engineering. Software Configuration Management Activities, Change Control Process, Software Version Control, An Overview of CASE Tools. Estimation of Various Parameters such as Cost, Efforts, Schedule/Duration, Constructive Cost Models (COCOMO), Resource Allocation Models, Software Risk Analysis and Management. Software Quality Assurance: SQA Plans, ISO 9000 models, SEI-CMM Model	**8**
	Total	**45**

Text Books:

1. R. S. Pressman," Software Engineering: A Practitioners Approach", McGraw Hill.
2. P.K.J. Mohapatra," Software Engineering (A Lifecycle Approach)", New Age International Publishers

Reference Books:

1. Ian Sommerville," Software Engineering", Addison Wesley.
2. Pankaj Jalote:" An Integrated Approach to Software Engineering", Narosa Publishing House.
3. Carlo Ghezzi, M. Jarayeri, D. Manodrioli," Fundamentals of Software Engineering", PHI Publication.
4. Rajib Mall," Fundamentals of Software Engineering", PHI Publication.
5. Pfleeger, "Software Engineering", Macmillan Publication.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 524 Course Title: **Virtual Reality**
2. Contact Hours: L: 3 T: - P: -
3. Semester: V

4. Pre-requisite:

5. Course Outcomes: After completion of the course students will be able to

1. Demonstrate an understanding of techniques, processes, technologies and equipment used in virtual reality
2. Identify appropriate design methodologies for immersive technology development, especially from a physiological perspective
3. Exploit the characteristics of human visual perception in Virtual Reality techniques
4. Provide rendering to VR specific problems
5. Effectively categorize the benefits/shortcomings of available VR technology platforms.
6. Discuss the use of geometry in virtual reality

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	**Introduction**: Goals, VR definitions, Birds-eye view (general, hardware, software, sensation and perception), Applications of VR, Technical framework, Mixed and Augmented Reality **Geometry of Virtual Worlds**: Geometric modeling, Transforming models, Matrix algebra, 2D and 3D rotations, Axis-angle representations, Quaternions, Converting and multiplying rotations, Homogeneous transforms, Eye Transforms, Canonical view transform, Viewport Transform	**8**
Unit - II	**Light and Optics:** Interpretations of light, Refraction, Simple lenses, Diopters, Imaging properties of lenses, Lens aberrations, Photoreceptors, Sufficient resolution for VR, Light Intensity, Eye movements for VR, Neuroscience of vision	**9**
Unit – III	**Visual Perception and Tracking Systems**: Depth perception, Motion Perception, Frame rates and displays, Orientation Tracking, Tilt drift correction, Yaw drift correction, Tracking with a camera, Perspective n-point problem, Filtering, Lighthouse approach	**9**
Unit – IV	**Visual Rendering**: Shading models, rasterization, Pixel shading, VR specific problems, Distortion shading, Post-rendering image wrap	**9**
Unit – V	**Audio**: Physics and physiology, Auditory perception, Auditory Localization, Rendering, Spatialization and display, Combining other senses, Spatial Sound **Interfaces:** Locomotion, Manipulation, System Control, Social Interaction, VR Engines and Other Aspects of VR, Evaluation of VR systems	**8**
	Total	**43**

Text Books:

1. Grigore C. Burdea , Philippe Coiffet, “Virtual Reality Technology”, Wiley-IEEE press
2. Marschner, Shirley "Fundamentals of Computer Graphics", 4th Edition, CRC Press 2016
3. LaValle "Virtual Reality", Cambridge University Press, 2016
4. “Virtual Reality”, Steve Lavalle (online open book)

Reference Books:

1. K. S. Hale and K. M. Stanney, “Handbook on Virtual Environments”, 2nd edition, CRC Press, 2015
2. George Mather,” Foundations of Sensation and Perception:” Psychology Press

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 523 Course Title: Bigdata and Machine Learning using Python
2. Contact Hours: L: 3 T: 1 P: 0
3. Semester: V

4. Pre-requisite: Basic Knowledge of Python

5. Course Outcomes: After completion of the course students will be able to

1. Critically analyze machine learning and knowledge discovery methodologies in order to assess best practice guidance when applied to real-world problems in specific contexts.
2. Investigate and evaluate key concepts of machine learning and bigdata techniques and assess when to apply such techniques in practical situations.
3. Explore the strengths and weaknesses of many popular machine learning approaches
4. Inspect the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and un-supervised learning.
5. Contextualize, develop machine learning models using python,
6. Students understand fundamental principles of bigdata and machine learning applications and technologies in order to provide strategies to address processing of datasets with a variety of characteristics

7. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	Introduction to Machine Learning: Introduction to modern data analysis, Definition of Machine Learning. Classification- K-Nearest Neighbors approach, Naïve Bayes, Decision Trees. Evaluation of performance Measures: Quality assessment: Accuracy, Precision, Recall, F - measure, Cnfusion-matrix, Kappa and learning curves-ROC	**9**
Unit – II	Complex datasets- Structured, semi-structured, unstructured. Multiclass and multi-label classification-Support vector machine. Ensemble Classification: Ensemble methods of Adaboost, Bagging, Boosting, Stacking and Random Forest. Validation Techniques: Hold out, K-Fold Cross Validation, Leave one out, Bootstrapping.	**8**
Unit – III	Frequent Item set Mining and Association Rules: Frequent item sets, apriori and FP-growth algorithms, association rules. Interestingness measures: support and confidence, and lift. Clustering and its basic techniques: the task of clusterization, Kmeans and its modifications (k-medoids and fuzzy cmeans clustering), Density-based methods: DB-scan and Mean Shift, Hierarchical clustering,	**10**
Unit – IV	Correlation and Regression Analysis- linear and multiple. Feature Selection and Dimensionality Reduction, Outlier detection, Feature selection versus feature extraction and generation, Principal Component Analysis. Deep Learning- Neural Methods, Basic ideas of Deep Learning, (Stochastic) gradient descent.	**10**
Unit – V	Bigdata: Hadoop: History of Hadoop- the Hadoop Distributed File System – Components of Hadoop Analysing the Data with HadoopScaling Out- Hadoop Streaming- Design of HDFS.	**10**
	Total	**47**

Text Books:

C. Bishop, “Pattern Recognition and Machine Learning, Springer”, 2006.

• Sheldon M. Ross,”Introduction to Probability and Statistics for Engineers and Scientists”, 4th edition, Academic Press; 2009.

• Han, J., Kamber, M., Pei, J. Data Mining: Concepts and Techniques, Third Edition. – Morgan Kaufmann Publishers, 2011. – 740 pp

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS521** Course Title: User Interface Design
2. Contact Hours: L: 3 T: - P: -
3. Semester: V

4. Pre-requisite:

- Basic HTML: Structure and HTML Tags, Images, List, Tables, Anchors and Form Elements
- CSS : Inline, Internal and External Stylesheet, Borders, Backgrounds, text and margin properties
- HTML5: Features, Semantic Tags, New Input Elements, Media Tags, Graphics and HMTL API's
- CSS3 : Features, border radius, box shadow, image border, custom web font, backgrounds - Advanced text effects(shadow), 2D and 3D Transformations, Transitions to elements, Animations

5. Course Outcomes: After completion of the course students will be able to

1. Understand the concepts and architecture of the World Wide Web. To understand and practice Markup Language.
2. Understand and practice Embedded Dynamic Scripting on Client-side Internet Programming. To understand and practice Web Development Techniques on client-side.
3. Investigate the features of NoSQL MongoDB Database and use Server-side JS Framework
4. Implement Client-side JS Framework.
5. Identify and deploy common abstract user interface components
6. Analyze a user interface context (consisting of one or more user types and one or more tasks/activities) and choose an appropriate type of user interface

8. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	HTML5: What is HTML5 - Features of HTML5 – Semantic Tags – New Input Elements and tags - Media tags (audio and video tags) – Designing Graphics using Canvas API - Drag and Drop features – Geolocation API - Web storage (Session and local storage). CSS3: What is CSS3 – Features of CSS3 – Implementation of border radius, box shadow, image border, custom web font, backgrounds - Advanced text effects(shadow) - 2D and 3D Transformations - Transitions to elements - Animations to text and elements	**8**

Unit - II	Responsive Design: What is RWD – Introduction to RWD Techniques – Fluid Layout, Fluid Images and Media queries - Introduction to RWD Framework Twitter Bootstrap – Bootstrap Background and Features - Getting Started with Bootstrap - Demystifying Grids – OffCanvas - Bootstrap Components - JS Plugins - Customization	**10**
Unit – III	Introduction - Core features - Data types and Variables - Operators, Expressions and Statements - Functions & Scope - Objects - Array, Date and Math related Objects - Document Object Model - Event Handling – Browser Object Model - Windows and Documents - Form handling and validations. Object-Oriented Techniques in JavaScript - Classes – Constructors and Prototyping (Sub classes and Super classes) – JSON – Introduction to AJAX. Introduction – jQuery Selectors – jQuery HTML - Animations – Effects – Event Handling – DOM – jQuery DOM Traversing, DOM Manipulation – jQuery AJAX	**10**
Unit – IV	What is NoSQL Database - Why to Use MongoDB - Difference between MongoDB & RDBMS - Download & Installation - Common Terms in MongoDB – Implementation of Basic CRUD Operations using MongoDB	**10**
Unit – V	Introduction - What is Node JS – Architecture – Feature of Node JS - Installation and setup - Creating web servers with HTTP (Request & Response) – Event Handling - GET & POST implementation - Connect to NoSQL Database using Node JS – Implementation of CRUD operations.	**7**
	Total	**45**

Reference Books:

1. Harvey & Paul Deitel & Associates, Harvey Deitel and Abbey Deitel, “Internet and World Wide Web - How To Program”, Fifth Edition, Pearson Education, 2011.
2. Achyut S Godbole and Atul Kahate, “Web Technologies”, Second Edition, Tata McGraw Hill, 2012.
3. Thomas A Powell, Fritz Schneider, “JavaScript: The Complete Reference”, Third Edition, Tata McGraw Hill, 2013.
4. David Flanagan, “JavaScript: The Definitive Guide, Sixth Edition”, O'Reilly Media, 2011
5. Bear Bibeault and Yehuda Katz, “jQuery in Action”, January 2008
6. Nathan Rozentals, “Mastering TypeScript”, April 2015
7. Nate Murray, Felipe Coury, Ari Lerner and Carlos Taborda, “ng-book, The Complete Book on Angular 4” September 2016
8. Amol Nayak, “MongoDB Cookbook Paperback” , November 2014
9. Krasimir Tsonev, “Node.js by Example Paperback”, May 2015

Reference Links:

1. Web link for Responsive Web Design - https://bradfrost.github.io/this-is-responsive/
2. Ebook link for JavaScript - https://github.com/jasonzhuang/tech_books/tree/master/js
3. Web link for TypeScript: https://www.typescriptlang.org/
4. Web link for Angular4.0: https://angular.io/
5. Web link for Node.js : https://nodejs.org/en/

6. Web link for MongoDB: https://www.mongodb.com/

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 601 Course Title: **Compiler Design**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VI

4. Pre-requisite: TCS 501

5. Course Outcomes: After completion of the course students will be able to

1. Understand the various phases and fundamental principles of compiler design like lexical, syntactical, semantic analysis, code generation and optimization.
2. Compare and contrast various parsing techniques such as SLR, CLR, LALR etc.
3. Use annotated tree to design the semantic rules for different aspects of programming language.
4. Implement lexical analyzer and parser by using modern tools like Flex and Bison.
5. Examine patterns, tokens & regular expressions for solving a problem in the field of data mining.
6. Design a compiler for concise programming language.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**Introduction, Lexical analysis:** Compilers; Analysis of Source Program; The Phases of a Compiler; Cousins of the Compiler; The grouping of phases; Compiler- Construction tools. Lexical analysis: The Role of Lexical Analyzer; Input Buffering; Specifications of Tokens; Recognition of Tokens.	**9**
Unit - II	**Syntax Analysis – 1:** The Role of the Parser; Context-free Grammars; Writing a Grammar; Top-down Parsing; Bottom-up Parsing. Operator-Precedence Parsing; LR Parsers; Using ambiguous grammars; Parser Generators	**9**
Unit – III	**Syntax-Directed Translation:** Syntax-Directed definitions; Constructions of Syntax Trees; Bottom-up evaluation of S-attributed definitions; L-attributed definitions; Top-down translation. **Run-Time Environments :** Source Language Issues; Storage Organization; Storage-allocation strategies, Storage-allocation in C; Parameter passing	**8**
Unit – IV	**Intermediate Code Generation:** Intermediate Languages; Declarations; Assignment statements; Boolean Expressions; Case statements; Back patching; Procedure calls. **Code Generation:** Issues in the design of Code Generator; The Target Machine; Run-time Storage Management; Basic blocks and Flow graphs; Next-use information; A Simple Code Generator; Register allocation and assignment; The dag representation of basic blocks; Generating code from dags.	**9**
Unit – V	**Code Optimization, Compiler Development:** Code Optimization: Introduction; The principal sources of optimization; Peephole optimization; Optimization of basic blocks; Loops in flow graphs.	**9**

	Compiler Development: Planning a compiler; Approaches to compiler development; the compiler development environment; Testing and maintenance.	
	Total	**44**

Text Books:

1. Alfred V Aho, Ravi Sethi, Jeffrey D Ullman: “Compilers- Principles, Techniques and Tools”, Pearson Education, 2007.

Reference Books:

1. Charles N. Fischer, Richard J. leBlanc, Jr.:” Crafting a Compiler with C”, Pearson Education, 1991.
2. Andrew W Apple: “Modern Compiler Implementation in C”, Cambridge University Press, 1997.
3. Kenneth C Louden: “Compiler Construction Principles & Practice”, Thomson Education, 1997.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 610 Course Title: **Design and Analysis of Algorithms**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VI

4. Pre-requisite: TCS 101, TCS 201,TCS 302

5. Course Outcomes: After completion of the course students will be able to

1. Understand various asymptotic notations to analyze time and space complexity of algorithms
2. Analyze the various paradigms for designing efficient algorithms using concepts of design and conquer, greedy and dynamic programming techniques
3. Provide solutions to complex problems using the concept of back tracking and branch and bound techniques.
4. Apply algorithm design techniques to predict the complexity of certain NP complete problems.
5. Implement Dijkstra's, Bellman-ford, Prims, Kruskal's algorithms to solve the real world problems like traveling salesman problem, job sequencing, packet routing etc
6. Apply pattern matching algorithms like Rabin Karp Algorithm, Brute-force techniques etc to find a particular pattern.

Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**Asymptotic Notations and Searching Algorithms** **Introduction to Algorithms -** What is an Algorithm, Rate of growth, Commonly used rate of growths, Types of analysis, Asymptotic Notations, Master theorem **Searching -** Linear search (sorted and unsorted), Iterative and recursive binary search, Tower of Hanoi and solving its recursion, Fibonacci and solving its recursion	**8**
Unit - II	**Sorting Algorithms Sorting -** Bubble sort, Insertion sort, selection sort, quick sort, randomized quick sort, merge sort, heap sort, counting sort, External sorting **Divide sorting algorithms into following types -** online sort, stable sort, in place sort, Comparison of sorting algorithms on the basis of number of swaps, by number of comparisons, recursive or iterative nature, time and space complexity	**10**
Unit – III	**Graph Algorithms** Representation of Graphs, Breadth-first search (BFS), depth-first search (DFS), topological sort, Difference between BFS and DFS **Data structures for disjoint sets -** Finding cycle in a graph, Finding strongly connected components **Minimum spanning trees -** Kruskal and Prim algorithms (Greedy Algorithms) **Single source shortest paths -** Dijkstra (Greedy	**12**

	Approach) and Bellman ford (Dynamic Programming) algorithms **All pair shortest paths -** The Floyd Warshall algorithm	
Unit – IV	**Algorithm Design Techniques - Greedy and Dynamic Programming** **Greedy algorithms -** Activity selection problem, Job sequencing problem, Huffman codes, fractional knapsack problem **Dynamic Programming -** Overlapping substructure property, Optimal substructure property, Tabulation vs Memoization, Fibonacci numbers, 0/1 Knapsack problem, Longest common subsequence, Matrix chain multiplication	**10**
Unit – V	**Hashing, String Matching and NP-Completeness** **Hashing Data Structure -** Introduction to Hashing, Hash function, Collision and collision handling, Collision handling - Chaining, Open addressing **String Matching -** Naive string-matching algorithm, The Rabin-Karp algorithm, The Knuth-Morris-Pratt algorithm **NP-Completeness** - Importance of NP-completeness, P, NP, NP Complete and NP hard problems, Polynomial time and polynomial time verification, The subset-sum problem, The traveling salesman problem	**10**
	Total	**50**

Text Books:

1. Thomas H. Cormen, Charles E. Leiserson, Ronal L. Rivest, Clifford Stein:" Introduction to Algorithms", 2nd Edition, PHI, 2006.

Reference Books:

1. Donald E.Knuth:"The Art of Computer Programming: Volume 1: Fundamental Algorithms",3rd Edition
2. Ellis Horowitz, Sartaj Sahni, SanguthevarRajasekaran:" Fundamentals of Computer Algorithms", 2nd Edition, University press, 2007.
3. Anany Levitin: "Introduction to the Design & Analysis of Algorithms", 2nd Edition, Pearson Education, 2007.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 604 Course Title: **Computer Network-I**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VI

4. Pre-requisite: TCS 505

5. Course Outcomes: After completion of the course students will be able to

1. 1.Characterize and appreciate computer networks from the view point of components and from the view point of services
2. Display good understanding of the flow of a protocol in general and a network protocol in particular
3. Model a problem or situation in terms of layering concept and map it to the TCI/IP stack
4. Select the most suitable Application Layer protocol (such as HTTP, FTP, SMTP, DNS, Bittorrent) as per the requirements of the network application and work with available tools to demonstrate the working of these protocols.
5. Design a Reliable Data Transfer Protocol and incrementally develop solutions for the requirements of Transport Layer
6. Describe the essential principles of Network Layers and use IP addressing to create subnets for any specific requirements

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	Introduction: Computer Networks and the Internet, Overall view: As components and as services; What is a protocol, what is a network protocol, Access Networks and Physical Media, Circuit and Packet Switching, Internet Backbone, Delays: Processing, Queing, Transmission and Propagation delays The Layered Architecture: Protocol Layering, The OSI Reference Model and the TCP/IP protocol stack, History of Computer Networking and the Internet	**11**
Unit - II	Application Layer: Principles and Architectures of Network Applications, Client and Server processes, the idea of socket, Transport services available to Application Layer especially in the internet. Application Layer Protocols: The Web and http: Persistent and Non-persistent connections, http message format, cookies, proxy server, conditional GET File Transfer Protocol Email: smtp, mail message formats, mail access protocols: pop3, imap, MIME DNS: Services, How it works, Root, Top-Level and Authoritative DNS servers, Resource Records, DNS messages A simple introduction to p2p file distribution: BitTorrent	**12**
Unit – III	Transport Layer: Introduction and Services, The Transport layer in internet, Difference between Connection Oriented and Connectionless services UDP: Segment structure, checksum in UDP	**6**
Unit – IV	Transport Layer2:The principles behind connection oriented data transfer, designing a connection oriented protocol, stop-and-wait, Go Back N, Selective Repeat	**6**

	TCP: Connection Establishment, TCP header, Sequence and acknowledgement numbers, Round Trip Time, Flow Control, Congestion Control	
Unit – V	Network Layer I: Introduction, Packet Forwarding and Routing, Difference between Virtual Circuits and Datagram networks, The internals of a router: Input ports, output ports, switching architecture The Internet Protocol(IP), Datagram format, IP fragmentation, IPv4 addressing, subnets, CIDR, classful addressing, DHCP, Network Address Translation(NAT), Universal Plug and Play as a provider of NAT, Internet Control Message Protocol(ICMP), IPv6 Header, Moving from IPv4 to IPv6: tunnelling, A brief discussion on IP security (Note: Network Layer will continue with Routing Algorithms in Computer Networks II in the next semester)	**10**
	Total	**45**

Text Books:

1. Computer Networking: "A Top Down Approach (5th edition)", Ross and Kurose, Pearson/Addison-Wesley

Reference Books:

1. Andrew Tanenbaum and David Wetherhall, "Computer Networks(5th edition)", Prentice Hall
2. Peterson and Davie, "Computer Networks: A System Approach (4th edition)", Elsevier
3. Forouzan, "Data Communication and Networking (4th edition)", McGraw Hill
4. William Stallings: "Data and Computer Communication", 8th Edition, Pearson Education, 2007
5. Nader F. Mir:" Computer and Communication Networks", Pearson Education, 2007.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 693 Course Title: **Full Stack Web Development**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VI

4. Pre-requisite: TCS 408, TCS 503

5. Course Outcomes: After completion of the course students will be able to

1. Describe the concepts of WWW including browser and HTTP protocol.
2. List the various HTML tags and use them to develop the user-friendly web pages.
3. Define the CSS with its types and use them to provide the styles to the web pages at various levels.
4. Develop the modern web pages using the HTML and CSS features with different layouts as per need of applications.
5. Use the JavaScript to develop the dynamic web pages.
6. Use server-side scripting with PHP to generate the web pages dynamically using the database connectivity.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
1	HTML Basics of HTML, formatting and fonts, commenting code, color, hyperlink, lists, tables, images, forms, XHTML, Meta tags, Character entities, frames and frame sets, Browser architecture and Web site structure. Overview and features of HTML5	8
2	CSS Need for CSS, introduction to CSS, basic syntax and structure, using CSS, type of CSS, background images, colors and properties, manipulating texts, using fonts, borders and boxes, margins, padding lists, positioning using CSS, Introduction to Bootstrap.	8
3	JavaScript and jQuery Client-side scripting with JavaScript, variables, functions, conditions, loops and repetition, Pop up boxes, Advance JavaScript: JavaScript and objects, JavaScript own objects, the DOM and web browser environments, Manipulation using DOM, forms and validations, DHTML: Combining HTML, CSS and JavaScript, Events and buttons. Introduction to jQuery. Introduction to XML, uses of XML, simple XML, XML key components, DTD and Schemas,	10

UNIT	CONTENTS	Contact Hrs
4	PHP Introduction and basic syntax of PHP, decision and looping with examples, PHP and HTML, Arrays, Functions, Browser control and detection, string, Form processing, Files. Advance Features: Cookies and Sessions, Basic commands with PHP examples, Connection to server, creating database, selecting a database, listing database, listing table names, creating a table, inserting data, altering tables, queries, deleting database, deleting data and tables. XAMPP Server Configuration.	11
5.	Web Application Deployment Concept of WWW, Internet and WWW, HTTP Protocol: Request and Response, Web browser and Web servers, Features of Web 2.0. Concepts of effective web design, Web design issues including Browser, Bandwidth and Cache, Display resolution, Look and Feel of the Website, Page Layout and linking, User centric design, Sitemap, Planning and publishing website, Designing effective navigation, Introduction to CMS. Ajax, AngularJS, JSON.	8
	Total	45

Text/ Reference Books:

1. Ralph Moseley and M. T. Savaliya ,"Developing Web Applications", , Wiley-India
2. "Web Technologies", Black Book, dreamtech Press
3. "HTML 5", Black Book, dreamtech Press
4. Joel Sklar ,"Web Design", Cengage Learning
5. "Developing Web Applications in PHP and AJAX", Harwani, McGrawHill
6. P.J. Deitel& H.M. ,"Internet and World Wide Web How to program", Deitel, Pearson

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 624 Course Title: **Security in social Network**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VI

4. Pre-requisite: Basic knowledge of Web Programming

5. Course Outcomes: After completion of this course students are able to

1. Understand the security and privacy concerns in Online Social Media
2. Develop Secure Web Applications
3. Understand the Architecture of Web and working with Social Media APIs
4. Perform social media analysis and visualisation using various tools and techniques
5. Know the various cases and data protection laws
6. Analyze the security parameters in social media

6. Detailed Syllabus

UNIT	CONTENT	Contact Hrs
Unit - I	**Understanding Working of Web and Related Technologies** Working with Linux and Python, Understanding Basics of FrontEnd and Backend Technologies (HTML, CSS, JavaScript, Node JS), Understanding the HTTP Methods, Client Server Architecture, Working of DNS, Introduction to Online Social Media (OSM) - Pros and Cons, Introduction to Social Media APIs - Twitter, Facebook	**12**
Unit - II	**Understanding Privacy and Security Concerns in Web** Misinformation on Social Media - Past Examples, Privacy and Social Media, Policing and Social Media, E-Crime and Social Media Social Media Attacks - Phishing, Reconnaissance, Fake Profiles, Social Engineering, Fake News, Profile Compromise Website Security and Threats - Cross-Site Scripting (XSS), SQL injection, Cross-Site Request Forgery (CSRF), Denial of Service (DoS), Clickjacking	**10**
Unit – III	**Online Social Media and Security** How to keep your account secure (Facebook, Google, Twitter, LinkedIn, Instagram) - Two factor Authentication, Creating Strong Passwords Use Social Media for Awareness, Understand the pattern of Fake News on Social Media, Understanding Dark Web and its Role in Security, Anonymous Web Browsing, Proxy Servers	**10**

Unit – IV	**Social Media Analysis** Learning Social Media Analysis on Publicly Available Twitter Data - Creating Twitter Developer Account, Download Twitter Data using API, Social Media Analysis using NLTK, Geo-Location Analysis, Gephi Network Visualization	**10**
Unit – V	**Case Studies and Data Protection Laws** Case Studies - Facebook and Cambridge Analytica and The Misuse of private data of 50 million Facebook users Data Protection Law - Need of Data Protection Laws, The General Data Protection Regulation (EU), Information Technology Act, 2000 (India)	**8**
	Total	**50**

Text Books:

1. Social Media Security: Leveraging Social Networking While Mitigating Risk 1st Edition by Michael Cross

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 671 Course Title: **Bigdata Storage and Processing**
2. Contact Hours: L: 3 T: 1 P: -
3. Semester: VI

4. Pre-requisite: TCS 404, TCS 408

5. Course Outcomes: After completion of the course students will be able to

1. Understand the various paradigms of Big Data
2. Use Hadoop distributed file system
3. Create the Hadoop Cluster
4. Explain NoSQL databases
5. Create the Map Reduce based programs
6. Understand the I/O system of Hadoop

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	Big Data Overview: Understanding Big Data, Capturing Big data, Benefitting from big data, management of big data, Organizing big data, Analyzing big data, Technological challenges from big data.	**8**
Unit - II	Hadoop Distributed File System (HDFS), HDFS design, HDFS concepts: Data node, name node, Command line interface, File system, Data flow, limitations	**9**
Unit – III	Hadoop I/O: Data integrity, compression, serialization, File based data structures, Concept of Map Reduce, features, types and formats, Working of Map Reduce: Shuffle and sort, Task execution, Job tracker, task tracker	**9**
Unit – IV	Setting up a Hadoop cluster: Basic system requirements, installation and cluster formation, Modes of installation: standalone, pseudo-distributed and distributed, purpose of different mode of installations and applications	**8**
Unit – V	NoSQL Databases:- RDBMS Vs NoSQL, Types of No SQL Databases, Architecture of NoSQL Databases, CAP Theorem, HBase Architecture, Reading and writing data	**9**
	Total	**43**

Text Books:

1. Tom White, Hadoop: A definitive guide, 3/e, O' Reilly Press, 2012.

Reference Books:

2. Fei Hu, Big Data: Storage, Sharing and Security, CRC Press, Taylor and Francis, 2016.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS-622 Course Title: **Cloud Computing Technologies**
2. Contact Hours: L: 3 T: 1 P: -
3. Semester: VI

4. Pre-requisite: Basic Knowledge of Mathematics

5. Course Outcomes: After completion of the course students will be able to

1. Remember basic cloud terminologies and understand the evaluation of cloud computing
2. Describe the Cloud Service Models with their dynamic interactions, Scope and Control
3. Understand and implement virtualization techniques used in cloud services
4. Describe the difference between parallel computing and distributed computing
5. Select appropriate cloud deployment model for provisioning cloud-based services with various security measures
6. Implement security features in the cloud

7. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	**Introduction to Cloud Computing:** A brief history, Technology Innovations: Mainframe Computing, Cluster Computing, Grid Computing, Virtualization, Web 2.0, SOA, cloud definitions; Basic Concepts and Terminologies: Cloud, IT Resources, On-premise, Off-premise, Cloud Consumers and Cloud Service Providers, Scaling (Horizontal Scaling, Vertical Scaling), Cloud Services (Amazon Web Services (AWS), Google App Engine, Microsoft Azure, Hadoop, Force.com and Salesforce.com), Different Stakeholders in CC, Total cost of ownership (TCO), Characteristics of cloud computing, Open Challenges	**8**
Unit - II	**Dynamic Interactions and Computing Architectures:** Cloud layered architecture, Service, Deployment, Scope, and Control: SaaS Interaction Dynamics and Software Stack Control, SaaS Benefits, Issues and Concerns, Suitability, and Recommendations, PaaS Dynamics and Software Stack Control, PaaS Benefits, Issues and Concerns, Suitability, and Recommendations, IaaS Abstract Interaction Dynamics and Software Stack Control, IaaS Operational View, IaaS Benefits, IaaS Issues and Concerns, and Recommendations	**10**
Unit – III	**Fundamental of Virtualization:** Virtualization Introduction, Characteristics of Virtualized Environments, Taxonomy of Virtualization Techniques, Execution Virtualization, System-level (Full Virtualization using Binary Translation, Hardware Assisted Virtualization, Para Virtualization, Partial Virtualization), Process-level Virtualization, Virtualization and Cloud Computing, Pros and Cons of Virtualization, Technology Examples, Xen: Para virtualization, VMware: Full Virtualization	**10**
Unit – IV	**Principles of Parallel and Distributed Computing** Eras of Computing, Parallel vs. Distributed Computing, Elements of Parallel Computing, What is Parallel Processing?, Hardware Architectures for Parallel Processing,	**10**

	Approaches to Parallel Programming, Levels of Parallelism, Laws of Caution, Elements of Distributed Computing, General Concepts and Definitions, Components of a Distributed System, Architectural Styles for Distributed Computing, Models for Inter-Process Communication, Technologies for Distributed Computing, Remote Procedure Call, Service Oriented Computing	
Unit – V	**Cloud deployment models and security perspectives:** Cloud Deployment models: Public Clouds, Private Clouds Hybrid Clouds, Community Clouds, Cloud security and privacy, cloud security challenges, cloud attackers, cloud attacks: VMM hyper jacking, VMM escape, Cross-VM side channel, Malware etc., AWS Hands-on: Amazon EC2 service, key pair generation, VM security group configuration, accessing VM remotely using secure shell protocol.	**7**
	Total	**45**

Text Books:

- Raj Kumar Buyya, Mastering the Cloud Computing, MacGraw Hill Education (India), 2013
- Tim Mather, SubraKumaraswamy, ShahedLatif: Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance

Reference Books:

- Michael Miller, Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online, Que Publishing, August 2008.
- David Chisnall, The Definitive Guide to Xen Hypervisor, Prentice Hall; Reprint edition (9 November 2007)

Other References (Journals & Conferences):

- M. Pearce, S. Zeadally, and R. Hunt, "Virtualization: Issues, security threats, and solutions," ACM Computing Surveys (CSUR), vol. 45, no. 2, p. 17, 2013.
- S. Subashini and V. Kavitha, "A survey on security issues in service delivery models of cloud computing," J. of Network and Computer Applications, vol. 34, no. 1, pp. 1-11, 2011.
- Preeti Mishra, Emmnuel Shubhakar Pilli, Vijay Varadharajan, and Udaya Tupakula, "Intrusion detection techniques in cloud environment: A survey," Journal of Network and Computer Applications, Elsevier, vol. 77, pp. 18-47, 2017
- Preeti Mishra, Ishita Verma, Saurabh Gupta," KVMInspector: KVM based Introspection Approach to Detect Malware in Cloud Environment," Int. J. of Information Security and Applications, vol. 51, pp. 18—47, 2020. ISSN: 2214-2126.

Name of Department:- Computer Science and Engineering

1. Subject Code: TIT 704 Course Title: **Cryptography and Network Security**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VII

4. Pre-requisite: TCS 604 Computer Networks - I

5. Course Outcomes: After completion of the course students will be able to

i. Classify security vulnerabilities involved in data communication over Internet and make use of classical algorithms to address the vulnerabilities.
ii. Make use of modern block ciphers to secure data transmission and storage
iii. Analyze challenges involved in key distribution and select approache that can be adopted
iv. Analyze strengths of public key algorithms and explore applications in exchange, authentication and hashing of messages.
v. Appreciate application of algorithms for ensuring access control, authentication, secured transmission of data at different layers.
vi. Appraise risks related to wireless, web, cloud security and measures to be adopted to secure organizational network.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	Introduction to security attacks, services and mechanism, introduction to cryptography. Conventional Encryption: Conventional encryption model, classical encryption techniques- substitution ciphers and transposition ciphers, cryptanalysis, stenography, stream and block ciphers.	**8**
Unit - II	Modern Block Ciphers: Block ciphers principals, Shannon's theory of confusion and diffusion, Modes of operations of block ciphers: ECB, CBC, OFB, CFB, Advanced Encryption Standard (AES) Traffic confidentiality, Key distribution, random numbers, Pseudo random number generation using Linear Congruential and Blum Blum Shub algorithms	**10**
Unit – III	Prime and relative prime numbers, modular arithmetic, Primality testing, Euclid's Algorithm for GCD and Extended Euclid's Algorithm for Multiplicative inverse Principals of public key crypto systems, RSA algorithm, security of RSA, key management, Diffle-Hellman key exchange algorithm Message Authentication: Requirements, Message Authentication Functions Cryptographic Hash Functions: Applications of Cryptographic Hash Functions, Secure Hash Algorithm (SHA)-512	**8**
Unit – IV	Authentication Applications: Kerberos and X.509 directory authentication service, electronic mail security-S /MIME IP Security: Architecture, Authentication header, Encapsulating security payloads, combining security associations, key management.	**9**
Unit – V	Wireless Network Security: Wireless Network Threats, Wireless Security Measures, Mobile Device Security, Security Threats and Security Strategy, IEEE 802.11 Wireless LAN Overview, The Wi-Fi Alliance, IEEE 802 Protocol	**10**

	Architecture, IEEE 802.11 Network Components and Architectural Model, IEEE 802.11 Services. Concept of Wireless LAN security and brief of phases of operation Web and Cloud Security: Web Security Considerations, Transport Layer Security, HTTPS, Cloud Security risks and Countermeasures; Data protection in cloud. System Security: The Need for Firewalls, Firewall Characteristics, Types of Firewalls	
	Total	**45**

Text Books:

1. William Stallings, “Cryptography and Network Security: Principals and Practice”, 7th Edition, Pearson, 2017
2. William Stallings, “Network Security Essentials – Applications and Standards”, 4th edition, Pearson Education, 2011

Reference Books

1. Behrouz A Forouzan, Debdeep Mukhopadhyay, “Cryptography and Network Security” Mc-GrawHill, 3rd Edition, 2015
2. Johannes A. Buchmann, “Introduction to Cryptography”, Springer-Verlag, 2012

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 703 Course Title: **Computer Networks-II**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VII

4. Pre-requisite: TCS 604

5. Course Outcomes: After completion of the course students will be able to

1. Analyze Global and Centralized Routing protocols and utilize tools (such as NS2) to examine routing protocols of LS and DV types
2. Evaluate and select the appropriate technology to meet Data Link Layer requirements
3. Specify the devices, components and technologies to build a cost-effective LAN
4. Appreciate issues for supporting real time and multimedia traffic over public network
5. Identify the availability strategies in a Network Management System that will improve network availability and limit the effects of failures
6. Implement client server applications with TCP/UDP Socket Programming

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	Routing Algorithms: Introduction, global vs decentralized routing, The Link State(LS) Routing Algorithm, The Distance Vector (DV) Routing Algorithm, Hierarchical Routing, Routing in the Internet: RIP, OSPF, BGP; Introduction to Broadcast and Multicast Routing	**9**
Unit – II	Link Layer and Local Area Networks: Introduction to Link Layer and its services, Where Link Layer is implemented?, Error detection and correction techniques: Parity checks, Checksumming, CRC; Multiple Access protocols: Channel Partitioning, Random Access (Slotted Aloha, Aloha, CSMA), Taking Turns; Link Layer Addressing: MAC addresses, ARP, Ethernet, CSMA/CD, Ethernet Technologies, Link Layer Switches, Switches vs Routers, VLANS	**10**
Unit – III	Multimedia Networking: Introduction, Streaming Stored Audio and Video, Real Time Streaming Protocol(RTSP), Making the Best of the Best Effort Services, Protocols for Real Time Interactive Applications: RTP, RTCP, SIP, H.323; Providing multiple classes of service.	**9**
Unit – IV	Network Management: What it is, Infrastructure of Network Management, The Internet standard Management Framework, SNMP	**9**
Unit – V	Network Programming: Sockets-Address structures, TCP sockets, creating sockets, bind, listen, accept, fork and exec function, close function; TCP client server: Echo server, normal startup, terminate and signal handling, server process termination, crashing and rebooting of server, host shutdown; Elementary UDP sockets: UDP echo server, lack of flow control with UDP	**8**
	Total	**45**

Text Book:

1. "Computer Networking A Top Down Approach, Kurose and Ross", 5th edition, Pearson

Reference Book:

1. Douglas E. Comer, Pearson ,"Internetworking with TCP/IP Volume 1 and 2 ",; 6 edition

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 704 Course Title: **Advanced Computer Architecture**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VII

4. Pre-requisite: TCS 404

5. Course Outcomes: After completion of the course students will be able to

1. Discuss the classes of computers, and new trends and developments in computer architecture
2. Study advanced performance enhancement techniques such as pipelines ,dynamic scheduling branch predictions, caches
3. Compare and contrast the modern computer architectures such as RISC, Scalar, and multi CPU systems
4. Critically evaluate the performance of different CPU architecture
5. Improve the performance of applications running on different cpu architectures.
6. Develop applications for high performance computing systems

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	Fundamentals: Computer Architecture and Technology Trends, Moore's Law, Classes of Parallelism and Parallel Architectures, Instruction Set Architecture: The Myopic View of Computer Architecture, Trends in Technology, Trends in Cost, Processor Speed, Cost, Power, Power Consumption, Fabrication Yield Performance Metrics and Evaluation: Measuring Performance, Benchmark Standards, Iron Law of Performance, Amdahl's Law, Lhadma's Law	**10**
Unit – II	Memory Hierarchy Design: Basics of Memory Hierarchy, Coherence and locality properties, Cache memory organizations, Cache Performance, Cache optimization techniques, Virtual Memory, Techniques for Fast Address Translation	**9**
Unit – III	Pipelining: What is pipelining, Basics of a RISC ISA, The classic five-stage pipeline for a RISC processor, Performance issues in pipelining, Pipeline Hazards	**10**
Unit – IV	Branches and Prediction: Branch Prediction, Direction Predictor, Hierarchical Predictors, If Conversion, Conditional Move Instruction Level Parallelism: Introduction, RAW and WAW, dependencies, Duplicating Register Values, ILP	**8**
Unit – V	Multiprocessor architecture: taxonomy of parallel architectures. Centralized shared-memory, Distributed shared-memory architecture, Message passing vs Shared Memory	**9**
	Total	**46**

Text/ Reference Books

1. John L. Hennessy, David A. Patterson, **"Computer Architecture:** A Quantitative Approach" 5th edition, Morgan Kaufmann
2. **"** by Kai Hwang **,"Advanced Computer Architecture"**, McGraw Hill Publishing

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS-726 Course Title: Artificial Intelligence and Pattern Recognition
2. Contact Hours: L: 3 T: - P: -
3. Semester: VII

4. Pre-requisite: Basic Knowledge of Mathematics and Image processing

5. Course Outcomes: After completion of the course students will be able to

1. Learn different components of artificial intelligence and basic problem solving methods.
2. Understand different types of pattern recognition techniques and decision making, any patterns in the clinical side can be recognized.
3. Propose solution to problem of pattern recognition using AI concepts.
4. Analyze and select best possible solution for decision-based problems for various image processing and pattern recognition applications.
5. Develop the algorithms to solve the problems using different types AI methodologies.
6. Implement the AI and pattern recognition problems for various applications.

8. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	Artificial Intelligence, AI Problems, AI Techniques, the Level of the Model, Problem Characteristics, Issues in the Design of Search Programs, Intelligent agents, perception and language processing, problem solving, searching, heuristic searching, game playing, Logics, logical reasoning.	**9**
Unit - II	Procedural Vs Declarative Knowledge, Representations & Approaches to Knowledge Representation, Forward Vs Backward Reasoning, Matching Techniques, Partial Matching, Fuzzy Matching Algorithms; Logic Based Programming, Bayes Theorem, Certainty Factors and Rule-Based Systems, Bayesian Probabilistic Inference, Bayesian Networks,	**9**
Unit – III	Patterns and features, training and learning in pattern recognition, pattern recognition approach, different types of pattern recognition. Multiple features, decision boundaries, estimation of error rates, histogram, kernels, window estimators, nearest neighbour classification, maximum distance pattern classifier, adaptive decision boundaries.	**9**
Unit – IV	Unsupervised learning, hierarchical clustering, Graph theories approach to pattern clustering, fuzzy pattern classifier, application of pattern recognition in medicine.	**8**
Unit – V	Introduction to Neural Networks,, Neural Network Structure for PR Applications, Physical Neural Networks, ANN Model, NN Based PR Association, Matrix Approaches and Examples	**8**
	Total	**43**

Text Books:

1. Elain Rich and Kevin Knight, “Artificial Intelligence”, 2nd Edition, Tata McGraw-Hill, 1993.
2. Earl Gose, Richard Johnsonbaugh, Steve Jost, “Pattern Recognition and Image Analysis”, Prentice Hall of India Pvt. Ltd., New Delhi, 1999.

Reference Books:

1. Introduction To Artificial Intelligence & Expert Systems, Patterson, PHI

2. Multi Agent systems- a modern approach to Distributed Artificial intelligence, Weiss.G, MITPress.

3. Artificial Intelligence: A modern Approach, Russell and Norvig, PrinticeHall

4. Neural Networks for pattern recognition, Christopher M.Bishop Oxford UniversityPress.

5. Pattern Classification, Richard O.Duda ,Wiley IndiaEdition

Name of Department: -Computer Science and Technology

1. Subject Code: **TCS 731** Course Title: Digital Forensics
2. Contact Hours: L: 3 T: - P: -
3. Semester: VII

4. Pre-requisite: Basic Knowledge of Computer and Security

5. Course Outcomes: After completion of the course students will be able to

1. Understand the importance of a systematic procedure for investigation of data found on digital storage media that might provide evidence of wrong-doing.
2. Identify and document potential security breaches of computer data that suggest violations of legal, ethical, moral, policy and/or societal standards
3. Use tools for faithful preservation of data on disks for analysis and find data that may be clear or hidden on a computer or another device
4. Work with computer forensics tools used in data analysis, such as searching, absolute disk sector viewing and editing, recovery of files, password cracking, etc.
5. Present the results of forensics analysis as an expert.
6. Discuss the Cyber Laws and Cyber Crimes.

9. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	**Introduction to Cybercrime and terminologies:** Introduction, Cyberspace and Criminal Behavior, Clarification of Terms, Web-Based Criminal Activity, Malware: Viruses and Worms, DoS and DDoS Attacks, Botnets and Zombie Armies, Spam, Ransomware and the Kidnapping of Information; Theft of Information, Data Manipulation, and Web Encroachment: Traditional Methods of Proprietary Information Theft, Trade Secrets and Copyrights, Political Espionage; Terrorism: Cyberterrorism; Dissemination of Contraband or Offensive Materials, Online Pharmacies, Online Gambling; Threatening and Harassing Communications; OnlineCredit Card Fraud, Fraud via Data Manipulation etc.	**8**
Unit - II	**Computer Forensics: Concepts, Terminology and Requirements:** Introduction to Digital Forensics, Classes of forensics science: Computer forensics, network forensics, mobile forensics, cloud forensics, Computer Forensics—An Emerging Discipline, Definitions, Principals of computer forensics: Rules for evidence, guidelines for evidence handling, Traditional Problems in Computer Investigations,Developing Computer Forensic Science Capabilities: Minimum Housing Requirements, Minimum Hardware Requirements, Minimum Software Requirements	**10**
Unit – III	**Forensic Models and Tools for Computer Forensics:** Generic Computer Forensics Process Model: Pre-process, Acquisition & Preservation, Analysis, Presentation, Post-Process etc. Computer Forensic tools: Encase, Helix, FTK, Autopsy, Sleuth kit Forensic Browser, FIRE, found stone Forensic ToolKit, Wireshark etc., Virtual Memory Forensics using LibVMI, Data Preservation,	**10**

	Duplication, and Verification Tools, Data Recovery/Extraction Utilities Data Analysis Software	
Unit – IV	**Searching and Seizing Computer-Related Evidence:**Traditional Problems Associated with Finding DigitalEvidence, Pre-search Activities: Warrant Preparation and Application, Plan Preparation and Personnel Gathering, Preparing a Toolkit,Traditional Equipment,Computer-Specific Equipment and Materials; On-scene Activities: Knock, Notice, and Document,Securing the Crime Scene,Determining the Need for Additional Assistance, Scene Processing, Locating Evidence, Seizure and Documentation of Evidence, Bagging and Tagging,Interviewing Witnesses, Scene Departure and Transportation of Evidence to Lab	**10**
Unit – V	**Computer crime and Legal issues:** Intellectual property, privacy issues, Criminal Justice system for forensic, audit/investigative situations and digital crime scene, investigative procedure/standards for extraction, preservation, and deposition of legal evidence in a court of law.	**7**
	Total	**45**

Text/Reference Books:

Computer Forensics and Cyber Crime: An Introduction (3rd Edition) by Marjie T. Britz, 2013.
Digital Forensics with Open Source Tools. Cory Altheide and Harlan Carvey, ISBN: 978-1-59749-586-8, Elsevier publication, April 2011

Guide to Computer Forensics and Investigations (4th edition). By B. Nelson, A. Phillips, F. Enfinger, C. Steuart. ISBN 0-619-21706-5, Thomson, 2009.

Fundamentals of Network Forensics ISBN:978-1-4471-7297-0 published by - Springer Nature Year:2016 authors- R. C. Joshi, Emmanuel S. Pilli

Name of Department: - Computer Science and Engineering

1. Subject Code: TCS 791 Course Title: **Sensor Networks**
2. Contact Hours: 3 - -
3. Semester: **VII**
4. Prerequisite: TCS631
5. Course Outcomes: After completion of the course students will be able to

1. Understand the wireless sensor networks basics and characteristics.
2. Analyze various medium access control protocols.
2. Describe routing and data gathering protocols.
3. Understand embedded operating systems.
5. Describe WSN applications.
6. Use various WSN protocols for different applications in real-time.

6. Details of the Course: -

UNIT	CONTENTS	Contact Hrs
Unit - I	**Introduction to Wireless Sensor Networks:**Introduction: Motivations, Applications, Performance metrics, History and Design factors, Traditional layered stack, Cross-layer designs, Sensor Network Architecture. **Characteristics of WSN:** Characteristic requirements for WSN - Challenges for WSNs – WSN vs Adhoc Networks - Sensor node architecture – Commercially available sensor nodes –Imote, IRIS, Mica Mote, EYES nodes, BTnodes, TelosB, Sunspot -Physical layer and transceiver design considerations in WSNs, Energy usage profile, Choice of modulation scheme, Dynamic modulation scaling, Antenna considerations.	**9**
Unit - II	**Medium Access Control Protocols:**Fundamentals of MAC protocols - Low duty cycle protocols and wakeup concepts – Contentionbased protocols - Schedule-based protocols - SMAC - BMAC - Traffic-adaptive medium access protocol (TRAMA) - The IEEE 802.15.4 MAC protocol.	**9**
Unit – III	**Routing and Data Gathering Protocols:**Routing Challenges and Design Issues in Wireless Sensor Networks, Flooding and gossiping – Data centric Routing – SPIN – Directed Diffusion – Energy aware routing - Gradient-based routing - Rumor Routing – COUGAR – ACQUIRE – Hierarchical Routing - LEACH, PEGASIS – Location Based Routing – GF, GAF, GEAR, GPSR – Real Time routing Protocols – TEEN, APTEEN, SPEED, RAP - Data aggregation - data aggregation operations - Aggregate Queries in Sensor Networks - Aggregation Techniques – TAG, Tiny DB	**10**

Unit – IV	**Embedded Operating Systems:**Operating Systems for Wireless Sensor Networks – Introduction - Operating System Design Issues - Examples of Operating Systems – TinyOS – Mate – MagnetOS – MANTIS - OSPM - EYES OS – SenOS – EMERALDS – PicOS – Introduction to Tiny OS – NesC – Interfaces and Modules- Configurations and Wiring - Generic Components -Programming in Tiny OS using NesC, Emulator TOSSIM	**8**
Unit – V	**Applications of WSN:** Current Trends in WSN, Future scope of WSN in Various Field like IOT, Machine Learning. WSN Applications - Home Control - Building Automation - Industrial Automation - Medical Applications - Reconfigurable Sensor Networks - Highway Monitoring - Military Applications - Civil and Environmental Engineering Applications - Wildfire Instrumentation - Habitat Monitoring - Nanoscopic Sensor Applications – Case Study: IEEE 802.15.4 LR-WPANs Standard - Target detection and tracking - Contour/edge detection - Field sampling	**9**
	Total	**45**

TEXT BOOKS

1.Kazem Sohraby, Daniel Minoli and TaiebZnati, " Wireless Sensor Networks Technology, Protocols, and Applications", John Wiley & Sons, 2007.
2.Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, Ltd, 2005.

REFERENCE BOOKS

1.K. Akkaya and M. Younis, "A survey of routing protocols in wireless sensor networks", Elsevier Ad Hoc Network Journal, Vol. 3, no. 3, pp. 325--349
2.Philip Levis, " TinyOS Programming"
3.Anna Ha´c, "Wireless Sensor Network Designs", John Wiley & Sons Ltd,

Name of Department:- Computer Science and Engineering

1. Subject Code: TIT 721 Course Title: **Business Intelligence**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VII
4. Pre-requisite: TCS671
5. Course Outcomes: After completion of the course students will be able to

    1. Understand the frameworks of Business Intelligence
    2. Categorize the structured, semi structured and unstructured data
    3. Create the schemas for data warehouse
    4. Perform the multi dimensional data modeling
    5. Use of different visualization techniques
    6. Use of Business Intelligence for ERP

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	Business view of Information Technology Application Business Enterprise Organization, its functions, and core business process, Baldrige Business Excellence Framework:- Leadership, Strategic Planning, Customer Focus, Measurement, Analysis and Knowledge Management Workforce Focus, Process Management Key Purpose of using IT in Business, Enterprise Application (ERP/CRM etc) and Bespoke IT Application	**10**
Unit - II	Types of Digital Data, Getting to know structured data, characteristics of structured data, were does structured data come from? , Hassle free Retrieval Getting to know unstructured data, were does unstructured data comes from? , How to manage unstructured data? How to store unstructured data? Solutions to storage challenges of unstructured data, how to extract information from stored unstructured data? , UIMA: A possible solution for unstructured data Getting to know semi structured data, where does semi structured data come from? , How to manage semi structured data, modeling semi structured data (OEM), How to extract information from semi structured data, XML : A solution for semi structured data management	**9**
Unit – III	Introduction to OLTP and OLAP OLTP:- Queries that an OLTP system can process, Advantage of an OLTP system, Challenges of an OLTP system, The queries that OLTP cannot answer OLAP:-one dimension data, two dimension data, three dimension data, should we go beyond the third dimension, queries that an OLAP system can process, Advantage of an OLAP system Different OLAP Architecture:-MOLAP, ROLAP, HOLAP	**9**

	Data Models for OLTP and OLAP, Role of OLAP tools in the BI Architecture OLAP operations on multidimensional data	
Unit – IV	BI component framework:- Business layer, Administration and operational layer, Implementation layer Who is BI for? - BI for Management, Operational BI, BI for process Improvement, BI to improve customer experience Business Intelligence Application:-Technology Solutions, Business solutions BI roles and Responsibility:-BI program team roles, BI project team roles, Best practice in BI/DW Popular BI tools Need for Data Warehouse, What is a Data Mart, Goals of a Data Warehouse Multidimensional data modeling:- Data modeling Basics, Types of Data model, Data Modeling Techniques, Fact table, Dimension table, Dimensional modeling life cycle	**8**
Unit – V	Measure, Metrics, KPIs, and Performance Management Understanding Measure and performance, Measurement system terminology, Fact based Decision Making and KPIS, KPI usage in companies Basics of Enterprise Reporting:- Report standardization and presentation practices, Enterprise reporting characteristics in OLAP world, Balance score cards, Dashboards, How do you create Dashboards, Scorecards Vs Dashboards BI and Cloud Computing, Business Intelligence for ERP systems	**9**
	Total	**45**

Reference Book:

R.N. Prasad and Seema Acharya ,"Fundamentals of Business Analytics", Wiley India

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 756 Course Title: **Human Computer Interaction**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VII

4. Pre-requisite: Fundamentals of Computer architecture

5. Course Outcomes: After completion of the course students will be able to

1. Explain the capabilities of both humans and computers from the viewpoint of human information processing.
2. Describe typical human–computer interaction (HCI) models, styles, and various historic HCI paradigms.
3. Apply an interactive design process and universal design principles to designing HCI systems.
4. Describe and use HCI design principles, standards and guidelines.
5. Analyze and identify user models, user support, socio-organizational issues, and stakeholder requirements of HCI systems.
6. Discuss tasks and dialogs of relevant HCI systems based on task analysis and dialog design.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	Introduction : Importance of user Interface – definition, importance of good design. Benefits of good design. A brief history of Screen design.The graphical user interface – popularity of graphics, the concept of direct manipulation, graphical system, Characteristics, Web user – Interface popularity, characteristics- Principles of user interface	**8**
Unit - II	Design process – Human interaction with computers, importance of human characteristics human consideration, Human interaction speeds, understanding business junctions	**8**
Unit – III	Screen Designing : Design goals – Screen planning and purpose, organizing screen elements, ordering of screen data and content – screen navigation and flow – Visually pleasing composition – amount of information – focus and emphasis – presentation information simply and meaningfully – information retrieval on web – statistical graphics – Technological consideration in interface design	**9**
Unit – IV	Windows – New and Navigation schemes selection of window, selection of devices based and screen based controls. Components – text and messages, Icons and increases – Multimedia, colors, uses problems, choosing colors	**8**
Unit – V	Software tools – Specification methods, interface – Building Tools. Interaction Devices – Keyboard and function keys – pointing devices – speech recognition digitization and generation – image and video displays – drivers	**8**

	Total	**41**

.**Text Books :**

1. “The essential guide to user interface design”, Wilbert O Galitz, Wiley DreamaTech.

2. “Designing the user interface”. 3rd Edition Ben Shneidermann , Pearson Education Asia.

Reference Book:

1. “Human – Computer Interaction”. ALAN DIX, JANET FINCAY, GRE GORYD, ABOWD, RUSSELL BEALG, PEARSON.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 722 Course Title: **Data Warehousing and Data Mining**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VII

4. Pre-requisite: Excellent knowledge of Database Management Systems

5. Course Outcomes: After completion of the course students will be able to

1. Describe the fundamental concepts, benefits and problem areas associated with datawarehousing
2. Understand the various architectures and main components of a data warehouse.
3. Find the issues that arise when implementing a data warehouse.
4. Understand the techniques applied in data mining.
5. Compare and contrast OLAP and data mining as techniques for extracting knowledge from a data warehouse.
6. Find the association rules.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	Overview, Motivation(for Data Mining),Data Mining-Definition & Functionalities, Data Processing, Form of Data Preprocessing, Data Cleaning: Missing Values, Noisy Data,(Binning, Clustering, Regression, Computer and Human inspection),Inconsistent Data, Data Integration and Transformation. Data Reduction:-Data Cube Aggregation, Dimensionality reduction, Data Compression, Numerosity Reduction, Clustering, Discretization and Concept hierarchy generation	**9**
Unit – II	Concept Description:- Definition, Data Generalization, Analytical Characterization, Analysis of attribute relevance, Mining Class comparisions, Statistical measures in large Databases. Measuring Central Tendency, Measuring Dispersion of Data, Graph Displays of Basic Statistical class Description, Mining Association Rules in Large Databases, Association rule mining, mining Single-Dimensional Boolean Association rules from Transactional Databases– Apriori Algorithm, Mining Multilevel Association rules from Transaction Databases and Mining Multi-Dimensional Association rules from Relational Databases	**8**
Unit – III	What is Classification & Prediction, Issues regarding Classification and prediction, Decision tree, Bayesian Classification, Classification by Back propagation, Multilayer feed-forward Neural Network, Back propagation Algorithm, Classification methods K-nearest neighbor classifiers, Genetic Algorithm. Cluster Analysis: Data types in cluster analysis, Categories of clustering methods, Partitioning methods. Hierarchical Clustering- CURE and Chameleon, Density Based Methods-DBSCAN, OPTICS, Grid Based Methods- STING, CLIQUE, Model Based Method –Statistical Approach, Neural Network approach, Outlier Analysis	**9**
Unit – IV	Data Warehousing: Overview, Definition, Delivery Process, Difference between Database System and Data Warehouse, Multi Dimensional Data Model, Data Cubes, Stars, Snow Flakes, Fact Constellations, Concept hierarchy, Process Architecture, 3 Tier Architecture, Data Marting	**9**

Unit – V	Aggregation, Historical information, Query Facility, OLAP function and Tools. OLAP Servers, ROLAP, MOLAP, HOLAP, Data Mining interface, Security, Backup and Recovery, Tuning Data Warehouse, Testing Data Warehouse	**8**
	Total	**43**

Books:

1. M.H.Dunham,"DataMining:Introductory and Advanced Topics" Pearson Education
Jiawei Han, Micheline Kamber, "Data Mining Concepts & Techniques" Elsevier

Name of Department:- Information Technology

1. Subject Code: TCS-799 Course Title: **Software Verification and Validation and Testing**
2. Contact Hours: L: 3 T: 1 P: -
3. Semester: VII

4. Pre-requisite: TIT 501

5. Course Outcomes: After completion of the course students will be able to

1. Demonstrate the application of verification and validation tasks and their outcomes during the software life cycle.
2. Apply various verification and validation techniques based on various characteristics of the system/software (safety, security, risk, etc).
3. Differentiate between the overall role of verification and validation and the specific role of software/system testing.
4. Compare and Contrast the theoretical and practical limitations to software verification and validation analysis.
5. Apply appropriate planning and scoping to a verification and validation effort based on the needs of the software system being developed.
6. Develop a software verification and validation plan that reflects an understanding of verification and validation objectives, and appropriate problem/risk identification and tracking.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**Introduction:** What is software testing and why it is so hard?, Error, Fault, Failure, Incident, TestCases, Testing Process, Limitations of Testing, No absolute proof of correctness, Overview of Graph Theory.	**11**
Unit – II	**Functional Testing:** Boundary Value Analysis, Equivalence Class Testing, Decision Table Based Testing, Cause Effect Graphing Technique. **Structural Testing:** Path testing, DD-Paths, Cyclomatic Complexity, Graph Metrics, Data Flow Testing, Mutation testing.	**12**
Unit – III	**Reducing the number of test cases:** Prioritization guidelines, Priority category, Scheme, Risk Analysis, Regression Testing, Slice based testing	**12**
Unit – IV	**Testing Activities:** Unit Testing, Levels of Testing, Integration Testing, System Testing, Debugging, Domain Testing.	**10**
Unit – V	**Object Oriented Testing:** Issues in Object Oriented Testing, Class Testing, GUI Testing, Object Oriented Integration and System Testing.**Testing Tools:** Static Testing Tools, Dynamic Testing Tools, Characteristics of Modern Tools.	
	Total	**45**

Text Books:

- William Perry, “Effective Methods for Software Testing”, John Wiley & Sons, New York, 1995.
- Cem Kaner, Jack Falk, Nguyen Quoc, “Testing Computer Software”, Second Edition, Van Nostrand Reinhold, New York, 1993.

- Boris Beizer, “Software Testing Techniques”, Second Volume, Second Edition, Van Nostrand Reinhold, New York, 1990.
- Louise Tamres, “Software Testing”, Pearson Education Asia, 2002

Reference Books:

- Roger S. Pressman, “Software Engineering – A Practitioner’s Approach”, Fifth Edition, McGraw-Hill International Edition, New Delhi, 2001.
- Boris Beizer, “Black-Box Testing – Techniques for Functional Testing of Software and Systems”, John Wiley & Sons Inc., New York, 1995.
- K.K. Aggarwal & Yogesh Singh, “Software Engineering”, New Age International Publishers, New Delhi, 2003.
- Marc Roper, “Software Testing”, McGraw-Hill Book Co., London, 1994.
- Gordon Schulmeyer, “Zero Defect Software”, McGraw-Hill, New York, 1990.
- Watts Humphrey, “Managing the Software Process”, Addison Wesley Pub. Co. Inc., Massachusetts, 1989.
- Boris Beizer, “Software System Testing and Quality Assurance”, Van Nostrand Reinhold, New York, 1984.
- Glenford Myers, “The Art of Software Testing”, John Wiley & Sons Inc., New York, 1979.

Name of Department:- Information Technology

1. Subject Code: **TCS 717** Cours **Robotics**

2. Contact Hours: L: 3 T: - P: -

3. Semester: VII

4. Pre-requisite: Basics of Mathematics

5. Course Outcomes

- Understanding the history, concepts and key components of robotics technologies.
- Understanding the control systems related to robotics.
- Analysis of various robot sensors, end effectors and their perception principles that enable a robot to analyse their environment, reason and take appropriate actions toward the given goal.
- Analyze the robot motion, kinematics, navigation and path planning.
- Designing the programming principles for robot control system.
- Plan, design and implement robotic systems, algorithms and software capable of operating in complex and interactive environments.

UNIT	CONTENTS	Contact Hrs
Unit - I	**FUNDAMENTALS OF ROBOTICS:** Brief history of robotics, robotics market, future perspectives of robotics, robot anatomy, robot drive systems, precision of movement, end effectors.	**8**
Unit – II	**CONTROL SYSTEM AND COMPONENTS:** Basic control system concepts and model, controllers, robot sensors and actuators, velocity sensors, power transmission system, modeling and control of single joint robot.	**8**
Unit – III	**ROBOT END EFFECTORS AND SENSORS:** Types of end effectors, mechanical grippers, other types of grippers, robot/end effectors interface, transducers and sensors.	**12**
Unit – IV	**ROBOT MOTION ANALYSIS AND CONTROL** Introduction to manipulator kinematics, homogeneous transformation, robot kinematics, manipulator path control, robot dynamics.	**6**
Unit – V	**MACHINE VISION:** Introduction to machine vision, Sensing and digitizing function in machine vision, image processing and analysis.	**6**
	Total	**40**

Text Book

M P Groover, *Industrial Robotics*, TMH, 2nd Edition

S R Deb and Sankha Deb, *Robotics Technology and Flexible Automation,* TMH.

Reference Books

S.K Saha, *Introduction to Robotics*, TMH, 2ndEdition

R.K. Mittal, I.J. Nagrath, *Robotics & Control*, TMH, 2005

Craig. J. J, *Introduction to Robotics- Mechanics and Control*, Pearson Education India, 3nd Edition.

COMPUTER SCIENCE AND ENGINEERING

1. Subject Code: **TCS-728** Course Title: **ANALYTICS IN ACTION**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VII

4. Pre-requisite: Basic Knowledge of Database Management System.

5. Course Outcomes:

- Critically analyze, how to collect, manipulate the data from the different sources in order to assess best practice guidance when applied to real-world problems in specific contexts.
- Select and apply suitable statistical measures and analyses techniques for data of various structure and content and present summary statistics
- Investigate and evaluate key concepts of data analytics techniques and assess when to apply such techniques in practical situations.
- Contextualize the analytical model using different data science tools.
- Students will be exposed to the power of clickstream analysis and the possibilities that can be unleashed from industry applications of data analytics.
- Employ advanced statistical analytical skills to test assumptions, and to generate and present new information and insights from large datasets

Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	Describing and Summarizing Data: Recognize trends in data and detect outliers, Summarize data sets concisely, Analyze relationships between variables, Create visual representations of data in Excel Define and calculate descriptive statistics Create scatter plots and calculate the correlation coefficient Analyzing Unstructured Data: Unstructured data such as text, images and video	**9**

Unit – II	Statistical Analytics: Probability Theory: Sample Spaces- Events - Axioms – Counting - Conditional Probability and Bayes' Theorem – The Binomial Theorem – Random variable and distributions : Mean and Variance of a Random variable-Binomial-Poisson-Exponential and Normal distributions. Curve Fitting and Principles of Least Squares- Regression and correlation	**8**
Unit – III	Database Revolutions- System Architecture- Relational Database- Database DesignData Storage- Transaction Management- Data warehouse and Data Mining- Information Retrieval. Big Data Revolution- CAP Theorem- Birth of NoSQL- Document Database—XML Databases- JSON Document Databases- Graph Databases. Column Databases	**10**
Unit – IV	Natural Language Processing:probabilistic language models, probability distributions over text sequences; text classification; sequence models; parsing sentences into syntactic representations; machine translation, and machine reading	**10**
Unit – V	Bigdata: Hadoop: History of Hadoop- the Hadoop Distributed File System – Components of Hadoop Analysing the Data with Hadoop- Scaling Out- Hadoop Streaming- Design of HDFS-Java interfaces to HDFS Basics- Developing a Map Reduce Application-How Map Reduce Works-Anatomy of a Map Reduce Job run-Failures-Job Scheduling-Shuffle and Sort – Task execution - Map Reduce Types and Formats- Map Reduce FeaturesHadoop environment.	**10**
	Total	**47**

I. TEXT BOOKS:

- Gaurav, V. (2013). Getting started with NoSQL: Your guide to the world and technology of NoSQL.

- Hastie, T., Tibshirani, R. and Friedman, J. (2013). The Elements of Statistical Learning.

- Tom White “Hadoop: The Definitive Guide” Third Edition, O’reilly Media, 2012.

- Sheldon M. Ross,”Introduction to Probability and Statistics for Engineers and Scientists”, 4th edition, Academic Press; 2009.

- Dan Sullivan, “NoSQL for Mere Mortals”, Addison-Wesley, 2015.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS-727 Course Title: **Intellectual Property rights for Engineers**

2. Contact Hours: L: 3 T: - P: -

3 Semester: VII

4. Objective: The main purpose of this course is to enhance creativity, innovation, competitiveness, and how to secure your ideas, innovation & inventions as well as to increase the economy of the country.

5 Learning outcomes:

- The students once they complete their academic projects, shall get an adequate knowledge on Intellectual Property rights for their innovative research works.
- Students will be able to understand the National and World Intellectual Property Organization (WIPO).
- Students will be able to understand and apply in the field of intellectual property protection.
- This will help in understanding the development cooperation program of WIPO in intellectual property and development.
- It will create a way for the students to catch up with Intellectual Property (IP) as a career option in various administration activities.
- students will be able to distinguish Technological and Legal Developments in Intellectual Property.

6. Details of the Course: -

Sl. No.	Contents	Contact Hours
Unit I	Introduction: The Concept of Intellectual Property, Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and traditional Knowledge – Trade Secret - IPR in India: Genesis and development – IPR in abroad – Major. The World Intellectual Property Organization (WIPO): History, Mission and Activities, Structure, Administration, Membership, Constitutional Reform Wider Consultation and Outreach	10
Unit II	Fields of Intellectual Property Protection: Patents, Copyright and Related Rights, Trademarks, Industrial Designs and Integrated Circuits, Geographical Indications, protection against unfair competitions.	8
Unit III	The Role of Intellectual Property in Development and WIPO's Development Cooperation Program: Industrial Property Protection and Development, The Promotion of Innovation, Licensing and the Transfer of Technology, Copyright and Development, The Development Cooperation Program of WIPO.	8

Unit IV	Administration and Teaching of Intellectual Property: Administration of Industrial Property, Administration of Copyright and Related Rights, The Patent and Trademark Attorney, The Teaching of Intellectual Property Law.	10
Unit V	Technological and Legal Developments in Intellectual Property: Computer Programs, Biotechnology, Reprography, Communication Technologies, A Complementary Approach to the Development of Intellectual Property Norms.	8
	Total	44

Reference Books:

- WIPO Intellectual Property Handbook, WIPO publication, No. 489 (E), WIPO 2004 Second Edition, Reprinted 2008, ISBN 978-92-805-1291-5
- Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
- Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.

Reference Journal:

- Journal of Intellectual Property Rights (JIPR): NISCAIR

Useful Websites:

- http://cipam.gov.in/
- https://www.wipo.int/about-ip/en/
- http://www.ipindia.nic.in/

Name of the Department: - Computer Science and Engineering

1. **Subject Code** TCS 812 **Course Title:** Graph Database
2. **Contact Hours: L: 3 T:- P: -**
3. **Semester IV**
4. **Pre-requisite:**
5. **Course Outcomes: After completion of the course students will be able to**

    1. Understand the various paradigms of Graph Databases.
    2. Comparison of Graph Databases with Other Databases.
    3. Understand the working of Graph Databases.
    4. Implementation of Graph Databases in Neo4j.
    5. Create, manage and query graph and RDF databases
    6. Develop small and medium-scale ontologies using the ontology languages of the Semantic We

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hours
Unit-1	Introduction to Graph Databases, why do Graph Databases Matter? Applications of Graph Databases, Challenges associated with Graph Databases, Tools and Technique used in Graph Databases.	**10**
Unit -2	Types of Databases, Difference between RDBMS and Graph Database, advantages, and disadvantages of Graph Databases, how to design reliable, scalable, and maintainable applications using Graph Databases.	**10**
Unit-3	Graph Databases: Storage and Query efficiency, Understand the building blocks of Graph Databases (Nodes, Labels, properties, and relationship)	**9**
Unit-4	Neo4j Introduction, Installation of Neo4j, How to work with Neo4j Browser, creating Nodes, Creating Relationship, read clauses, write clauses, general clauses, CQL functions, CQL Admin.	**12**

Books:

1. Graph Databases by Ian Robinson, Jim Webber and Emil Eifrem, O'Reilly.
2. Graph Databases in Action by Dave Bechberger and Josh Perryman, Manning Publications.

Name of Department:- Computer Science and Engineering

1. Subject Code: TDM 881 Course Title: **Disaster Management**
2. Contact Hours: L: 2 T: - P: -
3. Semester: VIII

4. Pre-requisite: None

5. Course Outcomes: After completion of the course students will be able to

1. Understanding foundations of hazards, disasters and associated natural/social phenomena of India
2. Study the various natural disasters.
3. Study the various manmade disasters.
4. Understand the disaster management principles.
5. Study the modern techniques used in disaster mitigation and management.
6. Formulate Technological innovations in Disaster Risk Reduction

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**Introduction, Definitions and Classification:** Concepts and definitions - Disaster, Hazard, Vulnerability, Resilience, Risks Natural disasters : Cloud bursts, earth quakes, Tsunami, snow, avalanches, landslides, forest fires,diversion of river routes (ex. Kosi river), Floods, Droughts Cyclones, volcanic hazards/ disasters(Mud volcanoes): causes and distribution, hazardous effects and environmental impacts of naturaldisasters, mitigation measures, natural disaster prune areas in India, major natural disasters in India with special reference to Uttarakhand.Man-induced disasters: water logging, subsidence, ground water depletion, soil erosion,, release of toxic gases and hazardous chemicals into environment , nuclear explosions	**9**
Unit – II	**Inter-relationship between Disasters and Development** Factors affecting vulnerabilities, differential impacts, impacts of development projects such asdams, embankments, changes in land use etc. climate change adaption, relevance of indigenous knowledge, appropriate technology and local resources, sustainable development and its role in disaster mitigation, roles and responsibilities of community, panchayat raj	**8**

	institutions/urban local bodies, state, centre and other stake holders in disaster mitigation.	
Unit – III	**Disaster Management (Pre-disasterstage, Emergency stage and Post Disaster Stage)** 1. Pre-disaster stage (preparedness): Preparing hazard zonation maps, predictably/forecastingand warning, preparing disaster preparedness plans, land use zoning, preparedness through information, education and communication (IEC), disaster resistant house construction, population reduction in vulnerable areas, awareness2. Emergency Stage: Rescue training for search & operation at national & regional level,immediate relief, assessment surveys 3. Post Disaster stage: Rehabilitation and reconstruction of disaster affected areas; urban disaster mitigation: Political and administrative aspects, social aspects, economic aspects, environmental aspects.	**9**
Unit – IV	**Disaster Management Laws and Policies in India** Environmental legislations related to disaster management in India: Disaster Management Act,2005; Environmental policies & programs in India-Institutions & nationalcentres for natural disaster mitigation: National Disaster Management Authority (NDMA):structure and functional responsibilities, National Disaster Response Force (NDRF): Rule andresponsibilities, National Institute Of Disaster Management (NIDM): Rule and responsibilities.	**8**
	Total	**34**

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Text Books:

- M MSulphey," Disaster Management", PHI, 2016

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 821 Course Title: **Soft Computing**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VIII

4. Pre-requisite: Good Knowledge of Artificial intelligence

5. Course Outcomes: After completion of the course students will be able to

1. Summarize about soft computing techniques and their applications
2. Analyze various neural network architectures
3. Design perceptrons and counter propagation networks.
4. Classify the fuzzy systems
5. Analyze the genetic algorithms and their applications.
6. Compose the fuzzy rules.

7. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	Fundamentals of ANN: The Biological Neural Network, Artificial Neural Networks -Building Blocks of ANN and ANN terminologies: architecture, setting of weights,activation functions - McCulloch-pitts Neuron Model, Hebbian Learning rule, Perceptionlearning rule, Delta learning rule.	**9**
Unit - II	Models of ANN: Single layer perception, Architecture, Algorithm, application procedure- Feedback Networks: Hopfield Net and BAM - Feed Forward Networks: BackPropogation Network (BPN) and Radial Basis Function Network (RBFN) – SelfOrganizing Feature Maps: SOM and LVQ	**8**
Unit – III	Fuzzy Sets, properties and operations - Fuzzy relations, cardinality, operations andproperties of fuzzy relations, fuzzy composition.	**9**
Unit – IV	Fuzzy variables - Types of membership functions - fuzzy rules: Takagi and Mamdani –fuzzy inference systems: fuzzification, inference, rulebase, defuzzification.	**9**
Unit – V	Genetic Algorithm (GA): Biological terminology – elements of GA: encoding, types ofselection, types of crossover, mutation, reinsertion – a simple genetic algorithm –Theoretical foundation: schema, fundamental theorem of GA, building block hypothesis.	**9**
	Total	**44**

TEXT BOOKS :

- S. N. Sivanandam, S. Sumathi, S.N. Deepa," Introduction to Neural Networks using MATLAB 6.0" , Tata McGraw-Hill, New Delhi, 2006
- S. N. Sivanandam, S.N. Deepa, "Principles of Soft Computing", Wiley-India, 2008.
- D.E. Goldberg, "Genetic algorithms, optimization and machine learning", Addison Wesley 2000.

REFERENCE BOOKS :

- Satish Kumar, Neural Networks – “A Classroom approach”, Tata McGraw-Hill, New Delhi, 2007.
- Martin T. Hagan, Howard B. Demuth, Mark Beale,” Neural Network Design”, Thomson Learning, India, 2002.
- B. Kosko,” Neural Network and fuzzy systems”, PHI, 1996.
- Klir& Yuan, “Fuzzy sets and fuzzy logic – theory and applications”, PHI, 1996.
- Melanie Mitchell, “An introduction to genetic algorithm”, PHI, India, 1996.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 822 Course Title: **Mobile Applications Development**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VIII

4. Pre-requisite: Excellent Knowledge of JAVA programming and Database Management System

5. Course Outcomes: After completion of the course students will be able to

1. Understand and apply the key technological principles and methods for delivering and maintaining mobile applications,
2. Evaluate and contrast requirements for mobile platforms to establish appropriate strategies for development and deployment,
3. Develop and apply current standard-compliant scripting/programming techniques for the successful deployment of mobile applications targeting a variety of platforms,
4. Carry out appropriate formative and summative evaluation and testing utilising a range of mobile platforms,
5. Interpret a scenario, plan, design and develop a prototype hybrid and native mobile application,
6. investigate the leading edge developments in mobile application development and use these to inform the design process.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	**Getting started with Mobility** Mobility landscape, Mobile platforms, Mobile apps development, Overview of Android platform, setting up the mobile app development environment along with an emulator, a case study on Mobile app development	**9**
Unit - II	**Building blocks of mobile apps** App user interface designing – mobile UI resources (Layout, UI elements, Draw-able, Menu), Activity- states and life cycle, interaction amongst activities. App functionality beyond user interface - Threads, Async task, Services – states and life cycle, Notifications, Broadcast receivers, Telephony and SMS APIs Native data handling – on-device file I/O, shared preferences, mobile databases such as SQLite, and enterprise data access (via Internet/Intranet)	**8**
Unit – III	**Sprucing up mobile apps** Graphics and animation – custom views, canvas, animation APIs, multimedia – audio/video playback and record, location awareness, and native hardware access (sensors such as accelerometer and gyroscope)	**9**

Unit – IV	**Testing mobile apps** Debugging mobile apps, White box testing, Black box testing, and test automation of mobile apps, JUnit for Android, Robotium, MonkeyTalk	**9**
Unit – V	**Taking apps to Market** Versioning, signing and packaging mobile apps, distributing apps on mobile market place	**8**
	Total	**43**

Text/ Reference Books:

1. Jeff McWherter, Scott Gowell, “Professional Mobile Application Development”,Wrox Publication.
2. “Mobile Application Development “Black Book, Dreamtech Press

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 823 Course Title: **Multimedia Systems and Data Compression**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VIII

4. Pre-requisite: Excellent knowledge of Computer Network and Communication

5. Course Outcomes: After completion of the course students will be able to

1. Demonstrate the basic concept of multimedia information representation. Delve into the requirement of multimedia communication in today's digital world.
2. Compare circuit mode and packet mode.Explain QoS and its applications.
3. Summarize the various multimedia information representations.
4. Compute Arithmetic, Huffman, Lempel –Ziv and Lempel–Ziv Welsh coding. Summarize Joint Photographic Expert Group (JPEG).
5. Differentiate between the audio compression techniques: PCM, DPCM, ADPCM, LPC, CELPC and MPEG. Differentiate MPEG1, MPEG2 and MPEG4.
6. Construct Haptic Interfaces and Virtual reality Systems

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	Introduction to Multimedia Presentation and Production, Multisensory Perception, Digital Representation of Data: Why it is required, Analog to Digital Conversion and Digital to Analog Conversion, Nyquist's Theorem, Relation between Sampling Rate and Bit Depth, Quantization Error, Fourier Representation, Pulse Modulation Describing Multimedia Presentations: SMIL Text: Typeface, Fonts; Tracking, Kerning, Spacing; Optical Character Recognition; Unicode Standard; Text to Voice	**10**
Unit - II	Data Compression: Approaches to compression, Basic Techniques: Run-Length Encoding ; Statistical Methods: Information Theory Concepts, Variable-Size codes, Shanon-Fano coding, Huffman coding, Adaptive Huffman Coding, Arithmetic Coding; Dictionary Methods: LZ77(Sliding Window), LZ78, LZW; Various LZ Applications, Deflate: zip and Gzip, LZMA and 7-zip.	**9**
Unit – III	Image types, how we see color, Vector and Bitmap, Color Models: RGB, CMYK, Lab, HSL, HSB/HSV, YUV, conversion between different color models; Basic steps of image processing, Scanner, Digital Camera, Gamma Correction, General Study of the following image formats: BMP,TIF,PNG,GIF,SVG Image Compression: Approaches, Image Transforms, The Discrete Cosine Transform, Detailed study of JPEG,JPEG-LS, Progressive image compression, JBIG	**9**

Unit – IV	Acoustics and the Nature of Sound Waves, Fundamental Characteristics of Sound, Musical Note, Pitch, Beat, Rhythm, Melody, Harmony and Tempo; Elements of Audio Systems, General study of Microphone, Amplifier, Loudspeaker, Mixer; Digital Audio, Synthesizers, MIDI, MIDI Connections, MIDI messages, Staff Notation, Sound Card, Audio Codecs: AIFF, WAV, Apple Lossless, Dolby TrueHD, DTS-HD Master Audio, FLAC, WMA, Audio Playing Software, Audio Recording using Dolby, Dolby Digital and Dolby Digital Surround EX, Voice Recognition Video: Analog Video, Transmission of Video Signals, Chroma Sub sampling, Composite and Components Video, NTSC, PAL and SECAM, Digital Video, High Definition TV, Video Recording Formats; Video Compression, MPEG, MPEG-4; General Study of the following formats and codecs: avi, flv, m4v	**9**
Unit – V	Multimedia Messaging Service(MMS): MMS standard, MMS Architecture, An Engineering perspective on How a MMS is created, sent and retrieved Introduction to Virtual Reality: Components of a VR System, Haptic Interfaces, Virtual Reality Programming, Impact of Virtual Reality, Case study of Second Life	**8**
	Total	**45**

Text/ Reference Books:

1. Ranjan Parekh, “Principles of Multimedia”, McGraw Hill, 2006
2. David Salomon, “Data Compression: The Complete Reference”, Fourth Edition, Springer Books
3. GrigoreBurdea, Philippe Coiffet, “Virtual reality technology, Volume 1”, Wiley, 2003

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 824 Course Title: **Computer Graphics**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VIII

4. Pre-requisite: Excellent knowledge of mathematics

5. Course Outcomes: After completion of the course students will be able to

1. Understand the structure of modern computer graphics systems
2. Understand the basic principles of implementing computer graphics primitives
3. Familiarity with key algorithms for modeling and rendering graphical data
4. Develop, design and problem solving skills with application to computer graphics
5. Gain experience in constructing interactive computer graphics programs using OpenGL
6. Assess the two dimensional viewing

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	Introduction: What is Computer Graphics and what are the applications, Graphics Systems: Video Display Devices, Raster Scan and Random Scan Displays, Flat Panel Displays, Three-Dimensional Viewing Devices; Video Controller, Input Devices, Graphics on the Internet, Graphics Software, Coordinate Representations Introduction to OpenGL, Basic OpenGL syntax, Related Libraries, Header Files, Display-Window Management using GLUT, A complete OpenGL program	**11**
Unit - II	Geometric Transformations: Two Dimensional Translation, Rotation and Scaling, Matrix Representations and Homogeneous Coordinates, Inverse Transformations, Composite Transformations, Reflection, Shear, Raster Methods for Geometric Transformations, Geometric Transformations in three-dimensional space, Affine Transformations, OpenGL Geometric-transformation programming examples Two Dimensional Viewing: Viewing Pipeline, The Clipping Window, Normalization and Viewport Transformations, Clipping Algorithms: Cohen-Sutherland Line Clipping, Liang-Barsky Line Clipping; Line clipping against non rectangular clip windows; Polygon Clipping: Sutherland-Hodgman, Weiler-Atherton; Curve Clipping, Text Clipping	**10**
Unit – III	Three Dimensional viewing, Transformations from world to viewing coordinates, 3-D clipping Three-Dimensional Object Representations: Polyhedra, Curved and Quadric surfaces, Blobby Objects, Spline Representations, Bezier Spline	**9**

	curves, Bezier Surfaces, B-Spline curves, B-Spline Surfaces, Octrees, Introduction to fractals	
Unit – IV	Visible Surface Detection Methods: Classification, Back-Face Detection, Depth-Buffer method, A-buffer method, Scan-Line method, Curved Surfaces Illumination Models and Surface Rendering Methods: Basic Illumination models- Ambient light, Diffuse Reflection, Specular Reflection and the Phong model; Polygon Rendering Methods: Gouraud Surface Rendering, Phong Surface Rendering; Ray Tracing, Texture Mapping	**10**
	Total	**40**

Text Book:

1. Computer Graphics with OpenGL by Donald Hearn and M. Pauline Baker, Third Edition, 2004, Pearson

Reference Books:

1. J.D. Foley, A. Dam, S.K. Feiner, Graphics Principle and Practice , Addison Wesley
2. Rogers, " Procedural Elements of Computer Graphics", McGraw Hill
3. Steven Harrington, "Computer Graphics: A Programming Approach" , TMH
4. Edward Angel, Interactive Computer Graphics – A Top Down Approach with OpenGL

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 826 Course Title: **Unix Systems Programming**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VIII

4. Pre-requisite: Excellent Knowledge of Operating Systems and C- programming

5. Course Outcomes: After completion of the course students will be able to

1. Experiment with various system calls
2. Compare between ANSI C AND C++ AND POSIX standards
3. Mapping the relationship between UNIX Kernel support for files
4. Use Kernel support for process creation and termination and memory allocation
5. Analyze Process Accounting process UID ,Terminal logins, network logins
6. Analyze process control,Deamon characteristics, coding rules and error logging

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	Introduction to System Programming, File I/O, Difference between Buffered and Unbuffered I/O, I/O system calls: open(), close(), read(), write(), Effect of I/O buffering in stdio and the kernel; synchronized I/O, Seeking to a file offset: lseek(), File control: fcntl(), Locking, Open file status flags, Open files and file descriptors, Duplicating file descriptors with dup, dup2 and fcntl. A brief recap of Buffered I/O, Forays into Advanced I/O	**9**
Unit - II	Processes: Process ID and Parent process ID, Memory layout, Running and Terminating a process, Waiting for Terminated child processes (fork, the exec family, wait, waitpid), copy on write, Advanced Process Management: Process Priorities, nice(), Setting the scheduling policy	**10**
Unit – III	Processes and Inter-Process Communication: Introduction, pipes, FIFOs, XSI IPC: Message Queues, Semaphores, Shared Memory	**9**
Unit – IV	Signals: Signal types and default actions, Basic Signal management, signal function, unreliable signals, SIGCLD, Sending signals, Signal sets, Blocking signals (the signal mask), Interruption and restarting of system calls, Designing signal handlers	**8**
Unit – V	Network Programming: Sockets, Operation, Socket types, Client/Server Models, Connection Based Services, Handling Out of Band Data, Connectionless Services, Design issues of Concurrent and iterative servers, Socket options	**9**
	Total	**45**

Text/ Reference Books:

1. Richard Stevens and Stephen Rago," Advanced Programming in the Unix Environment", Addison-Wesley
2. Michael Kerrisk," The Linux Programming Interface", No Starch Press

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 851 Course Title: **Storage Networks**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VIII

4. Pre-requisite: Knowledge of Database and Networking is required

5. Course Outcomes: After completion of the course students will be able to

1. Understand the different aspects of storage management
2. Describe the various applications of RAID
3. Compare and contrast the I/O Techniques
4. Categorize virtualization on various levels of storage network
5. Estimate the various requirements of storage management systems
6. Design a complete data center and enhance employability in this field

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	Introduction to Storage Technology Introduction to storage network, Five pillars of IT, parameters related with storage, data proliferation, problem caused by data proliferation, Hierarchical storage management, Information life cycle management (ILM), Role of ILM, Information value vs. time mapping, Evolution of storage, Storage infrastructure component, basic storage management skills and activities, Introduction to Datacenters, Technical & Physical components for building datacenters	**10**
Unit - II	Technologies for Storage network Server centric IT architecture & its limitations, Storage centric IT architecture & advantages, replacing a server with storage networks, Disk subsystems, Architecture of disk subsystem, Hard disks and Internal I/O channel, JBOD, RAID& RAID levels, RAID parity, comparison of RAID levels, Hot sparing, Hot swapping, Caching : acceleration of hard disk access, Intelligent Disk subsystem architecture Tape drives: Introduction to tape drives, Tape media, caring for Tape& Tape heads, Tape drive performance, Linear tape technology, Helical scan tape technology	**9**
Unit – III	I/O techniques I/O path from CPU to storage systems, SCSI technology – basics & protocol, SCSI and storage networks, Limitations of SCSI Fibre channel: Fibre channel, characteristic of fibre channel, serial data transfer vs. parallel data transfer, Fibre channel protocol stack, Links, ports & topologies, Data transport in fibre channel,	**10**

	Addressing in fibre channel, Designing of FC-SAN, components, Interoperability of FCSAN, FC products IP Storage: IP storage standards (iSCSI, iFCP, FCIP, iSNS), IPSAN products, Security in IP SAN, introduction to InfiniBand, Architecture of InfiniBand NAS – Evolution, elements & connectivity, NAS architecture	
Unit – IV	Storage Virtualization Introduction to storage virtualization, products, definition, core concepts, virtualization on various levels of storage network, advantages and disadvantages, Symmetric and asymmetric virtualization, performance of San virtualization, Scaling storage with virtualization	**9**
Unit – V	Management of storage Networks Management of storage network, SNMP protocol, requirements of management systems, Management interfaces, Standardized and proprietary mechanism, In-band& Out-band management, Backup and Recovery	**8**
	Total	**46**

Text/ Reference Books:

1. "Storage Networks: The Complete Reference", R. Spalding, McGraw-Hill
2. "Storage Networking Fundamentals: An Introduction to Storage Devices, Subsystems, Applications, Management, and Filing Systems", Marc Farley, Cisco Press.
3. "Designing Storage Area Networks: A Practical Reference for Implementing Fibre Channel and IP SANs, Second Edition", Tom Clark Addison Wesley

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 852 Course Title: **Pattern Recognition**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VIII

4. Pre-requisite: Knowledge of Probability theory, mathematics and algorithms is required

5. Course Outcomes: After completion of the course students will be able to

1. Explain and compare a variety of pattern classification, structural pattern recognition, and pattern classifier combination techniques.
2. Summarize, analyze, and relate research in the pattern recognition area verbally and in writing.
3. Apply performance evaluation methods for pattern recognition, and critique comparisons of techniques made in the research literature.
4. Apply pattern recognition techniques to real-world problems such as document analysis and recognition.
5. Implement simple pattern classifiers, classifier combinations, and structural pattern recognizers.
6. Describe the various clustering methods

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	Introduction : Machine perception, pattern recognition example, pattern recognition systems, the design cycle, learning and adaptation Bayesian Decision Theory : Introduction, continuous features – two categories classifications, minimum error-rate classification- zero–one loss function, classifiers, discriminant functions, and decision surfaces	**10**
Unit - II	Normal density : Univariate and multivariate density, discriminant functions for the normal densitydifferent cases, Bayes decision theory – discrete features, compound Bayesian decision theory and context Maximum likelihood and Bayesian parameter estimation : Introduction, maximum likelihood estimation, Bayesian estimation, Bayesian parameter estimation–Gaussian	**9**
Unit – III	Un-supervised learning and clustering : Introduction, mixture densities and identifiability, maximum likelihood estimates, application to normal mixtures, K-means clustering. Date description and clustering – similarity measures, criteria function for clustering Component analyses : Principal component analysis, non-linear component analysis; Low dimensional representations and multi dimensional scaling	**10**
Unit – IV	Discrete Hidden MorkovModels : Introduction, Discrete–time markov process, extensions to hidden Markov models, three basic problems for HMMs.	**9**

Unit – V	Continuous hidden Markov models : Observation densities, training and testing with continuous HMMs, types of HMMs	**8**
	Total	**46**

Text/ ReferenceBooks :

1. Richard O. Duda, Peter E. Hart, David G. Stroke. Wiley, “Pattern classifications”, student edition, Second Edition.
2. LawerenceRabiner, “Fundamentals of speech Recognition”, Biing – Hwang Juang Pearson education.

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS 855 Course Title: **Agile Software Engineering**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VIII

4. Pre-requisite: TCS 602

5. Course Outcomes: After completion of the course students will be able to

1. Describe two or more agile software development methodologies.
2. Identify the benefits and pitfalls of transitioning to agile.
3. Compare agile software development to traditional software development models.
4. Apply agile practices such as test-driven development, standup meetings, and pair programming to their software engineering practices.
5. Apply the agile testing
6. Describe the agile in current market scenario.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	**Fundamentals of Agile:** The Genesis of Agile, Introduction and background, Agile Manifesto and Principles, Overview of Agile Methodologies – Scrum methodology, Extreme Programming, Feature Driven development, Design and development practices in an Agile projects, Test Driven Development, Continuous Integration, Refactoring, Pair Programming, Simple Design, User Stories, Agile Testing, Agile Tools	**10**
Unit - II	**Agile Project Management:** Agile Scrum Methodology, Project phases, Agile Estimation, Planning game, Product backlog, Sprint backlog, Iteration planning, User story definition, Characteristics and content of user stories, Acceptance tests and Verifying stories, Agile project velocity, Burn down chart, Sprint planning and retrospective, Daily scrum, Scrum roles – Product Owner, Scrum Master, Scrum Developer, Scrum case study, Tools for Agile project management	**10**
Unit – III	**Agile Software Design and Programming:** Agile Design Principles with UML examples, Single Responsibility Principle, Open Closed Principle, Liskov Substitution Principle, Interface Segregation Principles, Dependency Inversion Principle, Need and significance of Refactoring, Refactoring Techniques, Continuous Integration, Automated	**9**

	build tools, Version control, Test-Driven Development (TDD), xUnit framework and tools for TDD	
Unit – IV	**Agile Testing:** The Agile lifecycle and its impact on testing, Testing user stories - acceptance tests and scenarios, Planning and managing Agile testing, Exploratory testing, Risk based testing, Regression tests, Test Automation, Tools to support the Agile tester	**9**
Unit – V	**Agile in Market:** Market scenario and adoption of Agile, Roles in an Agile project, Agile applicability, Agile in Distributed teams, Business benefits, Challenges in Agile, Risks and Mitigation, Agile projects on Cloud, Balancing Agility with Discipline, Agile rapid development technologies	**8**
	Total	**46**

Text Book:

1. Ken Schawber, Mike Beedle, “Agile Software Development with Scrum”, Pearson, 2008

Name of Department:- Computer Science and Engineering

1. Subject Code: TCS857 Course Title: **Game Theory**
2. Contact Hours: L: 3 T: - P: -
3. Semester: VIII

4. Pre-requisite: Excellent knowledge of programming and mathematics

5. Course Outcomes: After completion of the course students will be able to

1. Identify strategic situations and represent them as games
2. Find dominant strategy equilibrium, pure and mixed strategy Nash equilibrium,
3. Solve simple games using various techniques
4. Analyze economic situations using game theoretic techniques
5. Recommend and prescribe which strategies to implement
6. Find the needs of extensive games.

6. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit – I	**Introduction, Strategic Games:** What is game theory? The theory of rational choice; Interacting decision makers. Strategic games; Examples: The prisoner's dilemma, Bach or Stravinsky, Matching pennies; Nash equilibrium; Examples of Nash equilibrium; Best-response functions; Dominated actions; Equilibrium in a single population: symmetric games and symmetric equilibria. **Mixed Strategy Equilibrium:** Introduction; Strategic games in which players may randomize; Mixed strategy Nash equilibrium; Dominated actions; Pure equilibria when randomization is allowed, Illustration: Expert Diagnosis; Equilibrium in a single population, Illustration: Reporting a crime; The formation of players' beliefs; Extensions; Representing preferences by expected payoffs	**11**
Unit - II	**Extensive Games:** Extensive games with perfect information; Strategies and outcomes; Nash equilibrium; Subgame perfect equilibrium; Finding subgame perfect equilibria of finite horizon games: Backward induction. Illustrations: The ultimatum game, Stackelberg's model of duopoly, Buying votes.	**10**

	Extensive games: Extensions and Discussions: Extensions: Allowing for simultaneous moves, Illustrations: Entry in to a monopolized industry, Electoral competition with strategic voters, Committee decision making, Exit from a declining industry; Allowing for exogenous uncertainty, Discussion: subgame perfect equilibrium and backward induction	
Unit – III	**Bayesian Games, Extensive Games with Imperfect Information:** Motivational examples; General definitions; Two examples concerning information; Illustrations: Cournot's duopoly game with imperfect information, Providing a public good, Auctions; Auctions with an arbitrary distribution of valuations. Extensive games with imperfect information; Strategies; Nash equilibrium; Beliefs and sequential equilibrium; Signaling games; Illustration: Strategic information transmission. **Strictly Competitive Games, Evolutionary Equilibrium:** Strictly competitive games and maximization; Maximization and Nash equilibrium; Strictly competitive games; Maximization and Nash equilibrium in strictly competitive games. Evolutionary Equilibrium: Monomorphic pure strategy equilibrium; Mixed strategies and polymorphic equilibrium; Asymmetric contests; Variations on themes: Sibling behavior, Nesting behavior of wasps, The evolution of sex ratio	**10**
Unit – IV	**Iterated Games:** Repeated games: The main idea; Preferences; Repeated games; Finitely and infinitely repeated Prisoner's dilemma; Strategies in an infinitely repeated Prisoner's dilemma; Some Nash equilibria of an infinitely repeated Prisoner's dilemma, Nash equilibrium payoffs of an infinitely repeated Prisoner's dilemma	**8**
Unit – V	**Coalitional Games and Bargaining:** Coalitional games. The Core. Illustrations: Ownership and distribution of wealth, Exchanging homogeneous items, Exchanging heterogeneous items, Voting, Matching. Bargaining as an extensive game; Illustration of trade in a market; Nash's axiomatic model of bargaining	**8**
	Total	**47**

Text Books:

1. Martin Osborne: "An Introduction to Game Theory", Oxford University Press, Indian Edition, 2004.

Reference Books:

1. Roger B. Myerson: "Game Theory: Analysis of Conflict", Harvard University Press, 1997.

Name of Department: - Computer Science and Engineering

1. Subject Code: TCS844 Course Title: Bio computation
2. Contact Hours: L: 3 T: - P: -
3. Semester: VIII

4. Pre-requisite: Basic Knowledge of Statistics, Design and Analysis of Algorithms

5. Course Outcomes: After completion of the course students will be able to

1. **Understand the basic concepts of Bioinformatics and its significance in Biological data analysis.**
2. **Illustrate of sequence alignment and analysis.**
3. **Use computational methods, tools and algorithms employed for Biological Data Interpretation.**
4. Apply probabilistic model to determine important patterns.
5. Analyze and develop models for better interpretation of biological data to extract knowledge.
6. Implement complex problem as a collection of sub problems by applying modularization in applications using functions.

9. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	**DNA Computing:** DNA Structure, and Processing , Computational operations and Step involve in DNA computing, Bio-soft Computing Based on DNA Length, Beginnings of Molecular Computing- Adelman Experiment. RNA secondary structure prediction: Base pair maximisation and the Nussinov folding algorithm, Energy minimisation and the Zuker folding algorithm, Design of covariance models, Application of RNA fold.	**8**
Unit - II	**Genetic Algorithm:-** Basic Concepts, Reproduction, Cross over, Mutation, Fitness Value, Optimization using GAs; Applications of GA in bioinformatics.	**10**
Unit – III	**Hidden Markov Model:** Markov processes and Markov Models, Hidden Markov Models. Forward and Backward Algorithms, Most probable state path: Viterbi algorithm, Parameter Estimation for HMMs:-Baum-Welch Algorithm, EM Algorithm, Applications of	**8**

	profile HMMs for multiple alignment of proteins and for finding genes in the DNA.	
Unit – IV	**Support Vector Machines:** Introduction, hyperplane separation (maximum and soft margin hyperplanes), linear classifier, Kernel functions, Large Margin Classification, Optimization problem with SVM, Applications of SVM in bioinformatics. Bayesian network: Bayes Theorem, Inference and learning of Bayesian network, BN and Other Probabilistic Models.	**10**
Unit – V	**Artificial Neural Network:** Historic evolution – Perceptron, characteristics of neural networks terminology, models of neuron Mc Culloch – Pitts model, Perceptron, Adaline model, Basic learning laws, Topology of neural network architecture, single layer ANN, multilayer perceptron, back propagation learning, input - hidden and output layer computation, back propagation algorithm, Applications of ANN	**7**
	Total	**43**

Text Books:

1. Biological sequence analysis: Probabilistic models of proteins and nucleic acids by Richard Durbin, Eddy, Anders Krogh, 1998
2. An introduction to bioinformatics algorithms by Neil C. Jones, Pavel Pevzner. MIT Press.2004
3. Algorithms for Molecular Biology by Ron Shamir Lecture, Fall Semester, 2001
4. Neural Networks: A Systematic Introduction by Raul Rojas. Springer. 1996
5. DNA Computing: New Computing Paradigms By Gheorghe Paun, Grzegorz Rozenberg, Arto Salomaa.

Reference Books:

6. Bioinformatics: the machine learning approach by Pierre Baldi, Søren Brunak. MIT Press.2001

Name of Department:- Computer Science and Engineering

1. Subject Code: **TCS-845** Course Title: Advance Computer Vision
2. Contact Hours: L: 3 T: - P: -
3. Semester: VIII

4. Pre-requisite: Basic Knowledge of Mathematics

5. Course Outcomes: After completion of the course students will be able to

1. Recognize and describe both the theoretical and practical aspects of computing with images. Connect issues from Computer Vision to Human Vision.
2. Implement extraction of features from given image.
3. Use the concepts of motion analysis and video processing.
4. Explore fundamental concept of Augmented reality and virtual reality.
5. Analyze a wide range of problems and provide solutions related to the design of computer vision based systems through suitable algorithms, structures, diagrams, and other appropriate methods.
6. Build computer vision applications.

10. Detailed Syllabus

UNIT	CONTENTS	Contact Hrs
Unit - I	Introduction : Image Processing, Computer Vision and Computer Graphics , What is Computer Vision - Low-level, Mid-level, High-level , Overview of Diverse Computer Vision Applications: Document Image Analysis, Biometrics, Object Recognition, Tracking, Medical Image Analysis, Content-Based Image Retrieval, Video Data Processing, Multimedia, Virtual Reality and Augmented Reality	**8**
Unit - II	Feature Extraction: Edges detection; Line detectors (Hough Transform), SIFT, SURF, HOG, Gaussian derivative filters, Gabor Filters and DWT.	**10**
Unit – III	Background subtraction, Spatio-Temporal Analysis, KLT, Optical flow: Optical flow computation, Global and local optical flow estimation, Optical flow in motion analysis, Analysis based on correspondence of interest points: Detection of interest points.	**10**
Unit – IV	Augmented and Mixed Reality, Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality.	**8**
Unit – V	Case studies: Automatic activity recognition system and usage in various applications, Importance of computer vision in Smart City Development, Deep learning in computer vision.	**7**
	Total	**43**

Text Books:

Computer Vision: Algorithms and Applications, Richard Szeliski, 2010.

Reference Books:

Computer Vision: A Modern Approach, D. Forsyth and J. Ponce, 2010

Deep Learning: Algorithms and Applications, I. Goodfellow, Y. Bengio and A. Courville, 2017.

Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.

E. R. Davies, Computer & Machine Vision, Fourth Edition, Academic Press, 2012